

IDENTIFYING AD/HD SUBTYPES USING THE COGNITIVE ASSESSMENT
SYSTEM AND THE NEPSY

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The purpose of this study was to examine the ability of the Cognitive Assessment System (CAS) and the NEPSY, A Developmental Neuropsychological Assessment, to differentiate between the subtypes of Attention Deficit/ Hyperactivity Disorder (AD/HD). The CAS and NEPSY are neuropsychological instruments which provide norms for AD/HD children in general. This study examined the performance of the two subtypes of AD/HD on the CAS and NEPSY. In addition, this study examined the performance of the two AD/HD groups on the Screening Test for Auditory Processing Disorders (SCAN). Since AD/HD children tend to have difficulty with language, the SCAN was used to determine if any of the AD/HD subjects had auditory processing difficulties that might impact their performance on the CAS and/or NEPSY subtests. The sample consisted of 118 children between the ages of 8 and 12 years of age. Using the DSM-IV criteria, the children were diagnosed as having three types of AD/HD: A Predominantly Hyperactive-Impulsive Type (AD/HD-HI), a Predominantly Inattentive Type (AD/HD-I) and a Combined Type. The subtypes were also identified by the Attention Deficit Disorders Evaluation Scale-Home Version (ADDES-H). Only two subtypes, AD/HD-I and AD/HD-C, were identified by the ADDES-H. There were not enough AD/HD-HI subjects to include in the study. Therefore, this study focused on the AD/HD-I and AD/HD-C subtypes. A binomial logistic regression analysis was conducted on the

AD/HD-I and AD/HD-C subtypes with selected subtests of the NEPSY and the four PASS Scales of the CAS. Results indicated a significant difference between the AD/HD-I and AD/HD-C groups on the Tower subtest of the NEPSY and the Planning Scale of the CAS. The Tower and the Planning Scale are both purported measures of executive functioning; however, results of the Planning Scale were in an unexpected direction. No significant difference was found between the two AD/HD groups on the other subtests examined. The results of the SCAN analysis suggested there were no significant differences in auditory processing between the two AD/HD groups. Recommendations for future research are discussed.

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CHAPTER I

INTRODUCTION

Attention Deficit/Hyperactivity Disorder is the most frequently diagnosed neurobehavioral childhood disorder (Shaywitz & Shaywitz, 1992; Weiss & Hechtman, 1993). Research has shown that AD/HD affects as many as 3-7% of school-age children (Barkley, 1990; Szatmari, 1992). Children with AD/HD are at high risk for academic, social and emotional problems (Barkley, 1997a). Additionally, 30-80% of children diagnosed with AD/HD continue to have symptoms of AD/HD into adolescence and up to 65% of these continue to have problems into adulthood (Barkley, 1996; Weiss & Hechtman, 1993). AD/HD has been found to be associated with greater risk for low academic achievement, poor school performance, grade retention and school suspensions and expulsions (Barkley, 1990; Barkley, Fischer, Edelbrock, & Smallish, 1990; Barkley, Guevremont, Anastopoulos, DuPaul, & Shelton, 1993).

AD/HD children tend to be less accomplished at normal social interactions, reciprocity or cooperation with others than their non-identified peers (Barkley, 1997a; Whalen & Henker, 1992). For example, children with AD/HD appear to have difficulties in family and peer relationships (Barkley, Murphy, & Kwasnik, 1996; Biederman, Faraone, & Lapey, 1992; Barkley, Fischer, Edelbrock, & Smallish, 1990). Additionally, delinquent behavior or antisocial personality problems have been documented in 25-40% of adolescents or adults with a prior diagnosis of AD/HD (Barkley et al., 1990; Gittelman, Mannuzza, Shenker, & Bonagura, 1985; Weiss & Hechtman, 1993).

Moreover, children with AD/HD are more likely than their peers to develop significant substance abuse problems (Mannuzza, Klein, Bonagura, Konig, & Shenker, 1988).

Currently, because of the many comorbid disorders that share overt behavioral symptoms similar to children suffering from AD/HD, it is difficult to accurately diagnose the disorder and therefore provide appropriate and effective remediation. Therefore, in light of the social, academic, and behavioral problems associated with AD/HD, it is important to continue to examine this disorder and attempt to improve diagnostic methods and remediation. It is also important for people who live, play and work with AD/HD children to better understand the disorder. Research has indicated that because adults and peers often lack skills in interacting with them, AD/HD children tend to have low self-esteem (Barkley, 1997a). Therefore, a greater depth and breadth of understanding of AD/HD should assist and improve the interactions these children have with those around them.

There tends to be a great deal of controversy and confusion about the symptoms, causes and diagnosis of AD/HD among parents, teachers and health professionals. There is frustration by parents who watch the self-esteem of their child diminish as they struggle academically, are rejected by their peers and become angry and frustrated as failures mount. Similarly, many teachers have difficulty providing support and encouragement to the AD/HD child who continually disrupt the classroom and seeks undivided attention (Barkley, 1997a). Moreover, from the AD/HD child's perspective, his or her attention deficits, impulsivity and hyperactivity can be equally frustrating and

painful. It is important that research provide empirical evidence supporting the underlying etiology of the disorder in order to further understand and help the AD/HD child.

To date, controversy continues as to the specific etiology of this disorder. For example, as technology has progressed and provided improved knowledge of the brain, several underlying causes for AD/HD have been proposed. Current research is associating specific brain regions to symptoms of AD/HD, which is providing additional information to further understand the disorder (Das, Naglieri, & Kent, 1994).

The diagnosis of AD/HD is complicated by the fact that there are several associated comorbid disorders. For example, many children with AD/HD also suffer from anxiety or depression, both of which also have symptoms associated with inattention (Barkley, 1997a). Therefore, these symptoms of inattention can lead to misdiagnosis and incorrect treatment.

Moreover, the literature supports a high incidence of AD/HD and comorbid disorders; such as auditory processing disorders (Baker & Cantwell, 1990; Beitchman, Hood, Rochon & Peterson, 1989). Researchers have reported that 17-38% of children diagnosed with speech and language disorders also have AD/HD (American Speech-Language-Hearing Association [ASHA], 1996). Additionally, the developmental history of AD/HD children reveals a higher than normal incidence of recurrent Otitis Media, with a rate of 74% reported (Haggerman & Falkstien, 1987). Therefore, it is often difficult to determine whether the symptoms of inattention are primary or secondary symptoms in children with AD/HD.

However, unlike children who have only speech and language disabilities,

children with AD/HD appear to have attention difficulties related to deficits in executive functioning (August & Garfinkel, 1990; Koziol & Stout, 1992; Satterfield, Schell, Nichols, Satterfield, & Freese, 1990). Moreover, Tannock, Purvis, & Schachar (1993) have postulated that the many deficits in language based tasks may be the result of underlying impairment in executive functioning.

The DSM-IV (American Psychological Association, 1994) defines the current model of AD/HD and has established three subtypes of the disorder (See Appendix A). The subtypes of AD/HD include: Attention-Deficit/Hyperactivity Disorder - Predominately Inattentive Type (AD/HD-I), Attention-Deficit/Hyperactivity Disorder - Predominantly Hyperactive-Impulsive Type (AD/HD-HI) and Attention-Deficit/Hyperactivity Disorder, Combined Type (AD/HD-C). Unfortunately, a large portion of the literature has reported on AD/HD in general and has not examined the subtypes individually. In spite of the lack of specificity and clarity regarding the differentiation of subtypes overall, the research of Barkley (1998) suggests some meaningful differences, especially with respect to attention as the basis for differentiation of subtypes as defined by the DSM-IV. For example, Barkley (1998) proposes that AD/HD-HI and AD/HD-C differ from AD/HD-I with respect to the attentional mechanisms that underlie the symptomology. Specifically, Barkley (1998) suggests that the attention deficits seen in AD/HD-HI and AD/HD-C are not primarily problems that stem from inattention, but rather secondary manifestations in executive functioning and behavioral inhibition.

Barkley's (1998) research on AD/HD-I suggests that the attention problems associated with this subtype are reflective of true attention deficits. He proposes that a

deficit in speed of information processing rather than a deficit in executive functioning, (i.e., behavioral inhibition), underlie the symptomology in AD/HD-I. Thus, Barkley (1998) proposes that the current description of AD/HD is really a combination of two separate syndromes; specifically, inattention based on deficits in speed of information processing and secondary inattention based on executive functioning and behavioral inhibition.

Barkley's hypothesis is an important step toward further defining the subtypes of AD/HD. However, more research and assessment tools are needed to aid in the process of subtyping children with AD/HD. Several new assessment instruments have been developed to test attention, hyperactivity and impulsivity and have been normed on the AD/HD population. The present study is to provide additional information concerning two of these new assessment instruments and their ability to differentiate between subtypes of AD/HD. The NEPSY, A Developmental Neuropsychological Assessment (Korkman, Kirk, & Kemp, 1998) and the Cognitive Assessment System (CAS; Das, Naglieri & Kirby, 1994) are the two instruments that will be examined by this current project. Therefore, the purpose of this study is to evaluate the entire CAS and selected subtests from the NEPSY for their ability to distinguish between the subtypes of AD/HD. The ability to more accurately and easily categorize children according to specific subtypes will provide needed information for parents and teachers in their attempt to understand children with the disorder of AD/HD. Specific and accurate subtyping of AD/HD children will also aid psychologists, physicians and healthcare workers to provide improved diagnoses, treatment and remediation.

Specifically, the purpose of the current study is to examine the ability of the CAS

and selected subtests from the NEPSY to distinguish between the AD/HD-I and AD/HD-C subtypes on tests measuring AD/HD symptoms related to executive functioning, attention and language functions. As there is a high incidence of comorbid language disorders in children with AD/HD, this study will also examine auditory processing. Therefore, the two subtypes of AD/HD will be evaluated using the Screening Test for Auditory Processing Disorders (SCAN; Keith, 1986), an audiometric instrument that identifies deficits in auditory processing.

CHAPTER II

REVIEW OF THE LITERATURE

Attention Deficit Hyperactivity Disorder (AD/HD) is the current diagnostic label for children presenting with developmentally inappropriate levels of inattention, impulsivity and hyperactivity. Children with AD/HD display extensive variability in the severity of their symptoms. Additionally, the symptoms presented by AD/HD children vary within situations and environments. AD/HD is one of the most common childhood psychiatric disorders. Children with AD/HD comprise the largest referral source to medical health professionals in the United States (Barkley, 1998) with an estimated 3-7% of school-aged children being diagnosed with the disorder (Szatmari, 1992). Parental reports indicate a higher incidence of AD/HD among children, 30%, while teachers indicate that 10 to 20 % of school-aged children have AD/HD (Silver, 1992).

Etiology of AD/HD

There is currently no consensus about the etiology of AD/HD; however, there have been many hypotheses set forth over the years as to the underlying cause of this disorder. These predictions have ranged from brain dysfunction to dietary factors to environmental and social factors.

The effects of heredity have also been hypothesized to play a role in AD/HD. Twin studies have reported higher rates of hyperactivity in the biological parents of hyperactive children than adoptive parents of these children (Cantwell, 1975; Morrison &

Stewart, 1973). Additionally, studies have revealed shared symptoms of hyperactivity and inattention between monozygotic twins as compared to dizygotic twins (O'Connor, Foch, Sherry, & Plomin, 1980; Willerman, 1973). A study of 570 twins found that approximately 50% of the variance in hyperactivity and inattention in this group was a result of heredity, while as much as 30% may have been due to environmental factors (Goodman & Stevenson, 1989). This study further divided the twins into groups with and without clinically significant degrees of AD/HD. Findings within the group of clinically significant AD/HD revealed a heritability factor of .64 for hyperactivity and inattention. These results indicate that the more severe the AD/HD symptoms, the more genetic factors may be contributing to the disorder (Barkley, 1997b).

Other studies have indicated that the environment in which the child is reared may indirectly affect the severity of AD/HD symptoms. For example, family environmental factors have been found to play a role in comorbid disorders such as Oppositional Defiant Disorder and Conduct Disorder (Fischer, Barkley, Fletcher, & Smallish, 1993; Weiss & Hechtman, 1993). At one time it was thought that poor child rearing led to AD/HD (Silverman & Ragusa, 1992; Willis & Lovaas, 1977). These researchers proposed that parents who were not tolerant of hyperactive behaviors in their children would react negatively, thereby exacerbating the symptoms of hyperactivity.

Neurochemical differences in the brains of children with AD/HD as compared to normal children have been implicated as playing a role in AD/HD. For example, physiological imaging techniques such as the PET scan have documented underactivity of neurotransmitters in the frontal lobe of the brain, and associated this underactivity with reduced cortical arousal in executive control and language areas of the brain (Zametkin et

al., 1990). Researchers have also discovered the neurotransmitters dopamine and norepinephrine have been found deficient in individuals with attentional problems (Clark, Geffen, & Geffen, 1987a, 1987b). These researchers also reported that neurotransmitters play a role in several behaviors including attention, inhibition, motivation and response of the motor system. For example, Levy (1991) proposed that the underlying dysfunction in children with attention problems resulted from a malfunction of the dopaminergic pathways connecting the prefrontal and striatal centers. Moreover, at dopamine levels of less than 50-55%, rats have shown increased motor activity, irritability and misinterpretation of cues (Kalverboer, van Praag & Mendlewicz, 1978).

Perhaps, the most convincing evidence for an underlying etiology of AD/HD has been for those factors that are biological in nature and involve brain development and functioning (Barkley, 1997a). Research in the area of AD/HD has repeatedly supported this claim. Eighty years ago Still (1920) described children with symptoms similar to AD/HD. He reported that these deficits were probably a combination of brain impairments and hereditary factors. Moreover, recent advances in technology and neuropsychological testing have begun to provide empirical evidence implicating deficits in the frontal lobes, specifically the prefrontal cortex, as a causal factor in AD/HD. Evidence has been found that lesions or injuries to the prefrontal cortex additionally produce symptoms similar to AD/HD (Benton, 1991; Heilman, Voeller, & Nadeau, 1991; Levin, 1938; Mattes, 1980). Research has shown that individuals suffering from damage to the prefrontal area of the cortex appear to have deficits in sustained attention, inhibition, regulation of emotion and motivation and the ability to organize behavior across time (Fuster, 1989; Grattan & Eslinger, 1991; Stuss & Benson, 1986). These

symptoms are associated with AD/HD in children.

In a recent study, Casey et al. (1997) examined MRI data on AD/HD subjects collected by Castellanos et al. (1996). The authors were able to correlate the size of the prefrontal-striatal regions (prefrontal cortex, caudate nucleus and globus pallidus) in AD/HD children with tests of behavioral inhibition. Findings indicated that children with AD/HD performed significantly worse on tests involving response inhibition than normal subjects. Additionally, they found that the AD/HD children's performance on these tests of response inhibition correlated significantly with MRI measures of the size of the prefrontal-striatal region. The smaller the prefrontal-striatal region of the AD/HD child, the more impaired the performance on response inhibition tests. Additionally, Casey et al. (1997) found that these significant correlations were most often associated with the right side of the brain. Interestingly, no brain damage was revealed on the MRI of these AD/HD children, only reduced size of the brain region. These findings support prior research indicating that the right prefrontal-striatal region plays a role in both AD/HD and behavioral inhibition (Barkley, 1997a).

Diagnosis of AD/HD

With so many etiological considerations, it is no surprise that diagnostic criteria have varied and evolved over time. Professionals throughout the years have changed the definition and diagnostic criteria for attentional disorders. Originally, a broad range of difficulties such as learning problems, speech and motor activities in addition to inattention were noted in the diagnosis of AD/HD (Barkley, 1997a). Specifically, AD/HD has been described by terms such as Minimal Brain Dysfunction (Kessler, 1980) and Hyperkinetic Impulse Disorder (Laufer, Denhoff & Solomons, 1957). These terms

also reflect some of the perceived etiology of AD/HD at various times in history. Minimal Brain Dysfunction was originally thought to be a result of mild, usually undetectable, brain damage, while Hyperkinetic Impulse Disorder was thought to result from excessive stimulation to the brain (Barkley, 1997a).

The Diagnostic and Statistical Manual of Mental Disorders, published by the APA, has reflected changes in the understanding and definitions of what is now known as AD/HD. The second edition of the Diagnostic and Statistical Manual of Mental Disorders (APA, DSM-II, 1968) described the “Hyperkinetic Reaction of Childhood” that was characterized by problems with attention, distractibility and hyperactivity/restlessness.

The publication of the DSM-III (APA, 1980) replaced the prior DSM-II diagnosis of Hyperkinetic Reaction of Childhood with Attention-Deficit Disorder (with or without hyperactivity). The new definition placed more emphasis on the attentional and impulsive aspects of ADD and provided more specific symptoms and guidelines for the disorder. Criteria were divided between symptoms of inattention, impulsivity and hyperactivity with an onset prior to age seven and a duration of at least six months. In addition, criteria were to be distinguished from those of children diagnosed with schizophrenia, affective disorder or mental retardation.

Over time investigators felt that there was insufficient empirical evidence to substantiate subtypes related to the presence or absence of hyperactivity. This controversy resulted in the DSM-III-R (APA, 1987) version of AD/HD in which only diagnostic criteria for AD/HD with hyperactivity was set forth and ADD without hyperactivity was designated AD/HD Undifferentiated (Barkley, 1998). Therefore, the

name of the disorder was revised to Attention-Deficit Hyperactivity Disorder (APA, 1987). The specific guidelines set forth for this diagnosis were composed of a single list of symptoms rather than the three categories of inattention, impulsivity and hyperactivity. This list was a compilation of empirically derived behavioral criteria composed from rating scales and cutoff scores. Criteria were chosen to determine sensitivity, specificity and ability to discriminate between AD/HD and other psychiatric disorders as well as between AD/HD and normal children (Spitzer, Davies, & Barkley, 1990).

During the 1980's, the diagnostic pendulum swung back to a more differentiated diagnostic model as scientists began to question the ability of the attentional model to actually account for the behavioral problems seen in AD/HD (Barkley, 1981, 1984; Draeger, Prior, & Sanson, 1986; Haenlein & Caul, 1987; van der Meere & Sergeant, 1988a, 1988b). As opposed to attentional problems, there were accounts that children with AD/HD were experiencing difficulty with response inhibition and motor control when attending to a task (Barkley, Grodzinsky, & DuPaul, 1992; Pennington & Ozonoff, 1996; Schachar & Logan, 1990; Sergeant, 1988; Sergeant & Scholten, 1985; Sergeant & van der Meere, 1989, 1990). Additionally, investigators were discovering that hyperactivity and impulsivity were not distinct symptoms, but actually separate components of a single behavior. (Achenback & Edelbrock, 1983; Goyette, Conners, & Ulrich, 1978; Lahey et al., 1988).

These findings led to the development of separate criterion lists for AD/HD in the DSM-IV (APA, 1994). One list was composed of behaviors that included attentional deficits and the other hyperactive-impulsive behavior problems. The distinction between these two aspects of AD/HD once again resulted in diagnostic subtypes. However, in

addition to a subtype that consisted mainly of attentional problems without hyperactivity and impulsivity such as in the DSM-III (Attention-Deficit/Hyperactivity Disorder-Predominantly inattentive Type), for the first time there was a subtype of AD/HD that consisted of hyperactive-impulsive behavior with minimal attentional problems (Attention-Deficit/Hyperactivity Disorder-Predominantly Hyperactive-Impulsive Type).

Children with significant symptoms from both criterion lists made up a third subtype called Attention-Deficit/Hyperactivity Disorder-Combined Type. The Combined subtype is a combination of both hyperactive-impulsive and inattentive behaviors and is therefore considered to be the most severe (Barkley, 1998). Research has shown that the AD/HD-predominantly hyperactive-impulsive subtype actually appears to be a developmental predecessor of the combined type (Barkley, 1997a). For example, in a DSM-IV field trial for AD/HD, the hyperactive-impulsive type was mainly found among preschool children. The combined subtype of AD/HD was more prevalent in school-aged children, as was the inattentive subtype. Therefore, as a result of the 8-12 age range of subjects for this study, the inattentive subtype (AD/HD-I) and the combined subtype (AD/HD-C) will be the only subtypes examined.

Current AD/HD Subtype Definitions

As discussed above, the current view of AD/HD involves two major symptoms: inattention and hyperactive-impulsive behavior. Both symptoms involve aspects of attention, which has caused a significant amount of confusion in the literature. The multidimensional nature of attention has also made it difficult to clearly understand the attentional measures evaluated in these studies. Furthermore, past studies involving AD/HD did not divide subjects into subtypes, but tested them as a single group.

Therefore, it has been difficult to determine from this literature which symptoms of attention are attributable to which subtype of AD/HD. However, a consensus is emerging in recent literature about the nature of these subtypes.

First, according to Barkley, 1997a, studies involving inattention indicate that daydreaming, “spacing out,” “being in a fog,” frequent staring and being easily confused are predominant characteristics of children with AD/HD-I. Additional symptoms of AD/HD-I include lethargy, hypoactivity and passivity. (Barkley, DuPaul, & McMurray, 1990). Children with this inattentive subtype of AD/HD have more difficulty with following through on rules and instructions than normal children their age (Barkley, 1997a). Even during play, children with inattention problems spend less time at each activity or toy and frequently shift between them (Zentall, 1985). Inattentive children have also been found to return to an interrupted activity more slowly than normal children and are less likely to return to it at all (Schachar, Tannock, & Logan, 1993).

Parents and teachers often report that these children with inattention problems have more difficulty listening, are unable to concentrate, are more easily distracted and switch activities more often than their peers. However, such observations regarding distractibility might be situational rather than characterological. Thus, some researchers have shown that the problem for these children with attentional disorders may not be distractibility per se (Barkley, 1997a). In fact, some studies have shown that children with inattention problems are no more distractible than normal children (Campbell, Douglas, & Morgenstern, 1971; Cohen, Weiss, & Minde, 1972; Rosenthal & Allen, 1980; Steinkemp, 1980). Instead the problem appears to be one of weakened persistence of effort or inability to continue responding to tasks that have little intrinsic appeal or

minimal immediate rewards (Barkley, 1989a, 1997a).

For example, research has indicated that children with inattention problems have been found to exert less effort in correctly performing boring tasks and have been found to “look away” more than normal children during activities they have been asked to complete (Barkley & Ullman, 1975; Ceci & Tishman, 1984; Luk, 1985; Milich & Lorch, 1994). On the other hand, during a video game or favorite television show, these same children have been found to sustain attention for extended periods of time. In other words, their attention is not sustained by internal mechanisms, but results from external rewards or reinforcement.

Second, problems involving impulsive behavior and disinhibition are also a characteristic of AD/HD children. Impulsivity has been defined by Brown and Quay (1977) as a pattern of rapid, inaccurate responding to tasks. It has also been referred to as inability to inhibit responding (Barkley, 1997a; Gordon, 1979), poor delay of gratification (Campbell, 1987; Rapport, Tucker, DuPaul, Merlo, & Stoner, 1986), or inability to adhere to directives to control behavior in social contexts (Barkley, 1985; Kendall & Wilcox, 1979; Kindlon, Mezzacappa, & Earls, 1995). Impulsiveness presents problems with situations that involve deferred gratification or delaying a response. When given a choice between delaying gratification and working for a longer-term, larger reward, children with AD/HD will usually choose the immediate, smaller reward that requires less work and immediate gratification (Barkley, 1997a). These AD/HD children have been found to respond quickly without waiting for instructions to be completely provided or to totally understand what is being asked of them. This impulsive behavior results in careless errors and/or incomplete tasks. Additionally, impulsive children also have

difficulty waiting their turn. They often interrupt others during conversation, blurting out answers to questions without thinking them through and speaking without regard for others' feelings or social consequences to themselves (Barkley, 1998).

A third characteristic of AD/HD, as defined by the DSM-IV, is hyperactivity, which can be identified by difficulty sitting still, fidgetiness, constant movement such as running and climbing, difficulty staying seated in class and talking excessively. In addition, this overactive behavior of hyperactive children usually appears purposeless (Barkley, 1997a). Research has provided evidence that hyperactive children are more active than other children (Barkley & Cunningham, 1979; Barkley & Ullman, 1975; Luk, 1985; Porrino et al., 1983; Teicher, Ito, Glod, & Barber, 1996; Zentall, 1985), and have difficulty stopping an ongoing behavior (Milich, Hartung, Matrin, & Haigler, 1994; Schachar, Tannock, & Logan, 1993). Parents and teachers describe hyperactive children as “always on the go,” “acting as if driven by a motor” and “unable to wait” (Barkley, 1997a).

Factor analytic studies comparing impulsive behavior, inattention and hyperactivity have not been able to separate hyperactivity and impulsivity into different dimensions. In other words, if children are hyperactive they are also impulsive and vice versa (Achenback & Edelbrock, 1983; DuPaul, 1991; DuPaul, et al., 1997; Milich & Kramer, 1985). This finding raises questions as to whether hyperactivity and impulsiveness are two separate dimensions of behavior or are in reality two aspects of the same dimension.

Barkley (1997a) hypothesizes that the problem of behavioral disinhibition explains the symptoms of both impulsivity and hyperactivity (Barkley, 1997a).

Furthermore, Barkley (1997a) argues that in relation to AD/HD, attentional disorders may be secondary to a disorder of behavioral inhibition and regulation rather than a separate and distinct deficit. Inattention by itself does not distinguish AD/HD children from normal children; however, hyperactive, impulsive and disinhibited behavior does differentiate AD/HD children (Barkley, Grodzinsky, & DuPaul, 1992; Halperin, Matier, Bedi, Sharma, & Newcorn, 1992).

Therefore, it appears that the inability to inhibit behavior may be the true differentiating factor between AD/HD children with hyperactivity and impulsivity and AD/HD children with attentional deficits only. For example, AD/HD-C children talk more to other children (Barkley, Cunningham, & Karlson, 1983; Cunningham & Siegel, 1987), make more vocal noises than other children (Copeland & Weissbrod, 1978), blurt out incorrect verbal responses and disrupt the conversation of others (Barkley 1997a). It is possible that these behavioral problems may be evidence of a deficit in behavioral inhibition resulting from frontal lobe deficits.

Researchers have found the frontal lobe to be involved in several executive functions such as planning, inhibition, motor control, verbal fluency and working memory (Barley, 1998). It is interesting to note that verbal fluency is influenced by the frontal lobe and therefore may also be affected by a frontal lobe deficit. Many children diagnosed with AD/HD present with speech and language difficulties. Therefore, another area of research that is being investigated in relation to AD/HD is speech and language functioning.

Speech and Language Impairment

Approximately 10-54 % of children with AD/HD appear to have speech problems

as compared to 2-25 % in the normal population. (Barkley, DuPaul, & McMurray, 1990; Hartsough & Lambert, 1985; Munir, Biederman, & Knee, 1987; Szatmari, Offord, & Boyle, 1989). Love & Thompson (1988) reported that in a family clinic in Canada, three-fourths of the children with a language disorder also had AD/HD and two-thirds of the children who had AD/HD had a language disorder. Another study revealed that out of 22 children who had a diagnosis of AD/HD, 68% also had a diagnosis of a speech or language deficit (Trautman, Giddan, & Jurs, 1990).

There are no indications that children with AD/HD suffer from more hearing deficits than children without AD/HD; however, there is sufficient evidence that children with AD/HD have more middle ear infections or OME (Otitis Media with Effusion) than children who do not have AD/HD (Barkley, 1990). Additionally, children with AD/HD-HI were reported to have had more than ten ear infections while, among AD/HD children without hyperactivity, only one in five were found to have had that amount (Goldstein & Goldstein, 1992).

Children with AD/HD have also been found to exhibit more expressive language disorders than normal children, but not more receptive language disorders. For example, Weiss & Trokenberg (1986) found that some children with AD/HD exhibited a delayed onset of speech. These children did not babble until they were over a year old and their production of words and sentences was delayed in comparison to normal children (Barkley, 1990). Children with AD/HD have been found to have difficulty with well thought out speech and are better able to speak spontaneously because it does not require planning or organization (Westby & Cutler, 1994).

Barkley (1990) reported that children with AD/HD are likely to talk more than

normal children especially when speaking spontaneously and when using descriptive speech; however, AD/HD children appear to have more difficulty when providing explanations or confrontations requiring more organization and thought. During tasks that require the child to organize and generate speech in response to specific task demands, AD/HD children have been found to talk less and be less fluent. These children do not appear to use connecting words such as “but” or “so” to clarify information they present orally, and use more pauses and fillers such as “um” and “uh.” AD/HD children also misarticulate and, therefore, have more disorganized speech (Hamlett, Pelligrini, & Conners, 1987; Purvis & Tannock, 1997; Zentall, 1985).

These findings are consistent with those related to inattention, impulsivity and hyperactivity. Consequently, they may indicate that the speech difficulties of children with AD/HD are more related to higher-order cognitive processes. Such processes would involve organizing and monitoring thinking and behavior, or executive functioning, as opposed to difficulties in speech and language per se (Barkley, 1998).

In order to examine why AD/HD children often present with these language problems it is necessary to understand the linguistic process. According to Zentall (1993), spoken language is composed of two distinct but related categories: a) listening and b) language production. Zentall (1993) proposed that effective listening involves the ability to ignore irrelevant messages and information and focus on information important to the listener. Additionally, these researchers proposed that effective language production requires the listener to control and organize their thoughts. This involves initiating planned covert responses while retaining overt responses.

Bronowski (1967, 1977) supported Zentall’s theory of language and expanded

upon it. According to Bronowski, there are four properties of human language that are unique. He believed that human language was not only a means of communication but also involved reflection, during which a plan of action is proposed, played out and tested. Reflection occurs when there is a delay between the arrival of a stimulus or event and the response to that event. Bronowski (1977) proposed that the ability to inhibit and delay responses were core features in human language. He believed that it was not just the ability to inhibit a response but also the ability to delay a decision to respond that was unique in human language. He proposed that the prefrontal cortex is responsible for these functions.

In addition to spoken language, the ability to inhibit and delay appears to play a role in the learning of language. According to Miller & Gildea (1987) the learning of language involves two stages. The first stage is relatively short and involves identification, while the second stage takes more time and involves in-depth processing. For example, when learning the word “zebra” during the first stage, a child will learn to recognize the word, and that it is an animal with four legs; however, during the second stage the child will learn that a zebra is a member of the horse family, has black and white stripes and originates in Africa. Miller & Gildea (1987) have hypothesized that children with AD/HD-HI may only process the first stage and not the second. Therefore, it is possible that this deficit may be a result of impulsivity or inability to delay responding long enough to fully process the second stage of language acquisition. Because of this inability to delay, AD/HD children appear to have little difficulty recognizing new information such as “zebra” but have difficulty expressing the meaning of “zebra” in a readily understandable way. Therefore, this difficulty results in weak

expressive language skills.

Neuroanatomical Research

With behavioral and language symptoms indicating deficits in frontal lobe functioning, neuroanatomical research should provide direct corroborating evidence of this etiological focus. Indeed, recent advances in technology are providing evidence linking frontal lobe deficits and deficits in executive functioning, as well as clarifying the brain-behavior relationship that involves the components of attention. Several researchers have proposed theories concerning the role of prefrontal functions, specifically planning and inhibition, and their association with AD/HD. Each researcher's hypothesis has multiple and hierarchical features involved in the functioning of the brain in general. In order to understand the different elements associated with brain-behavior relationships it helps if one understands the hierarchical nature of brain performance. Therefore a brief description of Luria's theory is presented here.

In his description of the global functioning of the brain, Luria (1973) incorporated three principal functional units "whose participation is necessary for any type of mental activity" (p.43). Each of the units is hierarchical and multi-layered. The first unit is for "regulating tone or waking." This unit involves brainstem activity, including the reticular formation, and cooperates with the cortex to maintain an optimal level of cortical arousal necessary for proper brain functioning. According to Languis & Miller (1993), this unit is responsible for the initiation of selective focus and attention. A deficit in this unit would result in dysfunction in the following two units.

The second functional unit is for "obtaining, processing and storing information arriving from the outside world" (p.43) and is located in the brain regions underlying the

primary sensory and association areas of vision, audition and general sensation. These regions interact with the environment by receiving, coding and storing information (Lashley, 1964).

The third functional unit is necessary for “programming, regulating and verifying mental activity” (p.43) and is located in the frontal and prefrontal cortices. Luria (1966) believed the frontal lobes played a decisive role in the execution of all complex forms of activity.

Recent technology supports the involvement of the frontal lobe, the site of Luria’s third functional unit, in AD/HD. Positron emission tomography (PET) scans have indicated reduced whole brain glucose utilization, mainly in the right frontal area, specifically in the posterior-medial orbital areas (Zametkin et al., 1990) in children with AD/HD during tasks that involve planning and inhibition. Additionally, a quantitative analysis of an EEG study of boys with ADHD revealed increased slow wave activity, predominantly in the frontal regions, with decreased beta activity in the temporal regions compared to normal controls (Mann, Lubar, Zimmerman, Miller & Muenchen, 1992). Therefore, it appears that children with AD/HD-HI may have a frontal lobe dysfunction, which results in diminished executive functions such as inhibition, planning and impulse control.

In addition to the prefrontal cortex, research has indicated that the right hemisphere is the dominant hemisphere for tasks involving attention (Vallar & Perani, 1986). Magnetic resonance imaging (MRI) studies comparing AD/HD children with controls found smaller right frontal areas in children with AD/HD (Hynd, Semrud-Clikeman, Lorys, Novey, & Eliopoulos, 1990). Specifically, Castellanos et al., (1996)

found significant reductions in the size of the prefrontal cortex and parts of the corpus striatum, predominantly on the right side.

However, with respect to AD/HD-I, studies indicate that children with this inattentive subtype of AD/HD may have a deficit in the select/focus area of attention, the site of Luria's second functional unit. The second unit of Luria's hierarchical theory has been associated with the posterior cortical-subcortical sensory processing pathways (Fuster, 1989; Mesalun, 1990; Mirsky, 1987; Posner, 1988). Therefore, AD/HD-I children may be differentiated from those children with AD/HD-HI who reveal deficits with response inhibition associated with the orbital prefrontal areas of the brain (Barkley, 1990; Barkley, Grodzinsky, & DuPaul, 1992; Goodyear & Hynd, 1992).

Children with ADHD-I have also been found to have difficulty sustaining attention or vigilance due to a lack of persistence or effort. The structures that appear to be critical for sustaining attention and the maintenance of vigilance are located primarily in the brain stem. These structures include the tectum and mesopontine reticular formation (Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991) which are the location of Luria's first hierarchical unit of functioning. Patients that suffer tumors or damage to the brain stem and reticular formation demonstrate severe problems in maintaining vigilance for even short periods of time (Lindsley, 1960). Adams and Victor (1981) also provided evidence that damage to the white matter pathways of the reticular formation serving the midbrain resulted in difficulty sustaining attention. These different brain regions involved in attention and their corresponding association with symptoms of AD/HD provide further evidence for the possibility that AD/HD-I and AD/HD-HI are two distinct disorders.

Neuropsychological Assessments

The development of neuropsychological tests, specifically designed to aid in identifying relationships between brain functioning and behavior, have made important contributions to the field of assessment. Traditional IQ testing based, on the works of researchers such as Binet and Wechsler, have made intelligence testing one of the most important contributions of psychology to society (Anastasi & Urbins 1997). However, there is controversy as to the effectiveness of these tools for the diagnosis of learning disabilities (LD) and attention deficits (Naglieri, 1997). For example, there has been little support for the differentiation of LD and AD/HD groups based on IQ scales (Kavale & Forness, 1984; Mueller, Dennis, & Short, 1986). Naglieri and Das (1997) stated that the omission of planning and attention measures in the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974) and the Kaufman Assessment Battery for Children (Kaufman & Kaufman, 1983) is likely the reason these tests do not identify groups such as LD and AD/HD well (Clarizio & Veres, 1983; Hale & Landino, 1981; Kavale & Forness, 1984; Mueller, Dennis, & Short, 1986; Naglieri, 1985; Naglieri & Haddad, 1984; Sattler, 1982).

Advances in technology since the development of the IQ tests in the early 20th century have increased understanding of specific abilities. (Naglieri, 1999). As stated earlier in this paper, deficits in planning and attention have become associated with AD/HD. Therefore, many new instruments have been utilized to assess for these different aspects of AD/HD. For example, tests of vigilance, such as the Continuous Performance Task (CPT; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956) and the Test of Variable Attention (TOVA; Greenberg & Kinschi, 1996) are popular instruments

for assessment of response inhibition and impulsivity which are associated with the AD/HD child. These tests involve the child observing a screen while individual symbols are rapidly and intermittently flashed on the screen. The child is required to press a button when a specific symbol is projected on a screen at a rapid pace. The child is told to press a button when a certain stimulus or pair of stimuli in sequence appears on the screen.

The scores derived from these tests include the number of correct responses, the number of target stimuli missed (omission errors) and the number of responses following non-target or incorrect stimuli (commission errors). The latter score is presumed to tap both sustained attention and impulse control whereas the two former measures are believed to assess sustained attention only (Sostek, Buchsbaum, & Rapoport, 1980). Research on these measures has not been well established. They are used frequently for AD/HD evaluations; however there are reports of a high degree of false-negative results in the diagnosis of children as normal when in fact they have had an attention deficit (Barkley & Grodzinsky, 1994; DuPaul, Anastopoulos, Shelton, Guevremont, & Meteira, 1992).

The American Academy of Child and Adolescent Psychiatry guidelines for acceptable practice parameters states that continuous performance tests “generally are not useful in diagnosis because they suffer from low specificity and sensitivity” (AACAP, 1977, p. 87S). In contrast, Gordon (1993) reported that performance on a continuous performance task provides one more piece of information concerning a child’s functioning which contributes both to the overall clinical decision regarding diagnosis, but also about the severity of the AD/HD symptoms and possible treatment interventions.

Additionally, the use of neuropsychological assessments has increased significantly in recent years as a means of identifying more specific cognitive abilities of children, including their strengths and weaknesses. These instruments have the ability to assess specific cognitive factors such as memory, language and attention. These new instruments enable a comprehensive approach to assessment for measurement of specific features of a child. For example, the multidimensional nature of AD/HD demands the assessment of these specific behaviors of hyperactivity, impulsivity and attention that are involved in AD/HD. More research and assessment tools are needed to aid in the process of identifying and subtyping children with AD/HD.

Two assessment methods that have recently been developed are the Cognitive Assessment System (CAS) and The NEPSY, A Developmental Neuropsychological Assessment. The CAS (Das, Naglieri, & Kirby, 1994) and the NEPSY (Korkman, Kirk, & Kemp, 1998) are new instruments that measure cognitive processing in children from ages 3 to 17. According to the authors of these instruments, a goal for the development of these tests was the progression from a traditional IQ general ability approach to a theory-based multidimensional approach to assessment. Additionally, these authors report that they have attempted to build on contemporary research in human cognition to design their assessment instruments.

The CAS and the NEPSY are both based on the research of A. R. Luria (1966, 1980, 1982). Luria's research, reported earlier in this paper, describes intelligence as composed of functional units of abilities underlying the performance of certain tasks. Luria associated these functional units with specific regions of the brain. The CAS and NEPSY both provide the theory-driven approach of Luria. Additionally, these two

instruments provide a broader approach to the examination of a child's cognitive profile with the corresponding association to brain regions that previous neuropsychological instruments lacked. This specific data provides the ability to obtain a more distinctive neuropsychological profile for each child.

The Cognitive Assessment System

The CAS (Das, Naglieri, & Kirby, 1994) is designed to evaluate the cognitive processing of children ages 5 to 17. The purpose of the CAS is to measure specific cognitive abilities, which are defined as Planning, Attention, Simultaneous, and Successive (PASS) Cognitive processes. These PASS abilities are the basic building blocks of intelligence, which are described as functional units by Luria (1966, 1980, 1982). Recent evidence from factorial analysis has shown that Luria's PASS four-factor model was supported (Naglieri, Das, & Kirby, 1990) and that the four PASS processes are independently involved in mental activity.

The description of AD/HD as a delay in response inhibition and executive functioning (Barkley, 1994) associated with the prefrontal cortex suggests that these children have difficulty with planning (e.g. self-regulation, inhibition of responses, control of behavior) as measured in the CAS (Naglieri, 1999). Additionally, children with AD/HD are expected to receive low scores on tests of attention. According to Naglieri (1999), children with AD/HD-I have shown markedly depressed scores on the CAS Attention scale and are especially prone to low scores on attentional measures. A recent study of the CAS examined the Planning and Attention scales with a sample of AD/HD children who were diagnosed with either AD/HD-I, AD/HD-HI or AD/HD-HI with a comorbid reading disorder (RD). Results indicated that the Planning scale was

significantly impaired for all three groups; however, the children with AD/HD-HI and RD had significantly worse performance on the Attention scale than the other two groups (Dye, 1999). Therefore, it appears that the Planning and Attention scales of the CAS are the scales most sensitive to children with AD/HD.

Description of the Cognitive Assessment System Scales

The Planning Scale is purported to measure the planning process which involves cognitive control, utilization of processes and knowledge and the ability to self-regulate and achieve a desired goal (Naglieri, 1999, p. 2). According to Naglieri & Das (1997), “Planning is a mental process by which the individual determines, selects, applies and evaluates solutions to problems”. Planning is associated with Luria’s third functional unit corresponds with the frontal lobe, specifically the prefrontal cortex. The subtests involved in the Planning Scale of the CAS requires the child to develop a plan of action, evaluate its effectiveness and revise or reject the plan accordingly, prior to taking action.

The Attention Scales of the CAS measure processes of attention. These processes include focused attention, selective attention and resistance to distraction. Naglieri & Das (1997, p.3) describe attention as “a mental process by which the individual selectively focuses on particular stimuli while inhibiting responses to competing stimuli presented over time”. Attention corresponds with Luria’s first functional unit which is associated with the modulation of arousal and the maintenance of attention and is associated with the brainstem, diencephalon and medial portions of both hemispheres (Das, Naglieri, Kirby, 1994). The attentional processes assessed by the CAS require focused, selective and sustained attention as well as effort. The tasks require the child to sustain focus in the presence of competing demands on their attention.

The Simultaneous Scale and the Successive scale are the last two scales in the PASS model. Simultaneous and successive processing are both associated with the second functional unit described by Luria and are involved with receiving, processing and storing information. “Simultaneous processing is a mental process by which the individual integrates separate stimuli into a single whole or group” (Luria, 1970, p. 4). The subtests of the CAS require the child to visualize how separate elements are interrelated into a conceptual whole. There are strong verbal, non-verbal spatial and logical components to simultaneous processing. Therefore, simultaneous processing is important for the understanding of grammatical statements that require the integration of words into a whole idea. Specifically, simultaneous processing involves the comprehension of word relationships, prepositions and inflections in order for the individual to obtain meaning from the whole idea.

Naglieri & Das (1997, p. 5) describe successive processing as “a mental process by which the individual integrates stimuli into a specific serial order that forms a chain like progression”. Successive processing requires that each element is related only to those that precede it, and these stimuli are not interrelated. Therefore, the successive processing subtests of the CAS require the child to arrange items into a specified order. Additionally, the child must attend to and work with serial auditory presentations of linguistic material. The child is presented with a series of individual words without context or a series of words in a sentence. Successive processing is important in the understanding of language. It allows for the understanding of the meaning of speech when “the individual elements of the whole narrative always behave as if organized in certain successive series” (Luria, 1966, p.78). Consequently, the serial presentation of a

story determines the meaning.

The NEPSY

The diagnostic approach of the NEPSY (Korkman, Kirk, & Kemp, 1998), according to the authors, is rooted in the Lurian tradition and based on Luria's assessment of adults with acquired brain damage (Christensen, 1984; Luria, 1973, 1980). The NEPSY is designed to assess normal and atypical neuropsychological development in children ages 3-12. Additionally, the NEPSY is intended to measure abilities that are critical to the child's ability to learn and be productive both within the classroom as well as outside of school (Korkman, et al., 1998). The NEPSY is designed to be a flexible assessment tool and provide an overview of neuropsychological functioning as well as a full neuropsychological assessment.

The NEPSY is proposed to be sensitive to subtle deficits within and across five functional domains: Attention/Executive Functioning, Learning and Memory, Visual Spatial processing, Auditory Processing and Language Functioning. These domains are complex cognitive functions mediated by flexible and interactive neural networks (Luria, 1973, 1980). Therefore, it is possible to examine both basic and complex components that contribute to performance within and across the five functional domains (Korkman, Kirk, & Kemp, 1998).

The Lurian model proposes that behavior is comprised of the functioning of several hierarchical units, or cognitive domains, functioning in concert. Therefore, some subtests are designed to assess basic components within a functional domain, while other subtests are designed to assess secondary deficits that receive information from several functional domains (secondary deficit; Korkman, et al., 1998). According to Luria's

theory, if a subcomponent of a function is impaired, then the cognitive functions to which it contributes may also be impaired. Therefore, a basic principle underlying Luria's model is the identification of primary deficits underlying impaired performance in one functional domain that affect performance in other functional domains (Korkman, 1995). According to Korkman, et al., (1998), qualitative behavioral observations and impaired performance are needed to distinguish between primary and secondary deficits. Therefore, the NEPSY encourages documentation of behavioral observations during testing.

Description of the NEPSY Subtests

For the purposes of this study and in accordance with the identification of AD/HD, four subtests from two domains of the NEPSY battery were administered. These included two subtests from the Attention/Executive Function Domain and two subtests from the Language Domain.

The term *executive function* was originally defined within the context of cognitive theory (Brown & DeLoach, 1978; Neisser, 1967) and was further refined with the addition of the concept of efficient working memory (Shallice, 1982). Executive functioning is used in developmental neuropsychology to suggest planning and the use of flexible strategy (Denckla, 1996; Levin et al., 1991; Pennington, 1991; Pennington, Groisser, & Welsh, 1993). This assumption refers to the ability to sustain attention of task-relevant information while working on a task (Goldman-Rakic, 1992) and to mentally act on such information (Baddeley, 1991, 1992; Goldman-Rakic, 1992). The NEPSY is unique in its separation of executive functioning into an individual domain as well as in the identification of patterns from commission and omission errors acquired by

the child during performance on selected subtests.

The tower subtest is the first subtest in the Attention/Executive Function domain. The tower assesses the executive functions of planning, monitoring, self-regulation, and problem solving. The Auditory Attention and Response Set, the second subtest in the domain, is a continuous performance task, which assesses the child's ability to maintain selective auditory attention.

Language is also a primary functional domain assessed in neuropsychological testing and multiple subcomponents have been identified as necessary for proficient oral and written language. These subtests were included in this study in order to examine the possible relationship between children with AD/HD and expressive language problems.

The first test in the language domain assesses phonological processing. This task is divided into two segments. Part A of this subtest assesses the ability to identify words from segments and to form an auditory gestalt. Part B assesses phonological segmentation at the level of letter sounds and word segments. The child is required to make a new word by omitting a word segment (syllable) or letter sound (phoneme) or by substituting one phoneme for another (Korkman, et al.1998).

Naming is another important subcomponent of language and is the second task in the language domain. Naming demonstrates the ability to access information in semantic memory (Katz, 1996). Vellutino & Scanlon (1989) found that although word-finding may be secondary to a more generalized language disorder, word-finding deficits are also prevalent in children with reading disabilities (Denckla & Rudel, 1976; Korhonen, 1991; Scarborough, 1990; Wolf, 1986; Wolf & Goodglass, 1986; Wolf & Obregon, 1992). Additionally, children with AD/HD without a comorbid learning disability were also

found to be impaired on tests of verbal fluency when the task involved producing words starting with a specified phoneme, but not in producing words from a specified semantic category (Reader, Harris, Schuerholz, & Denckla, 1994). Word-finding problems have been obtained from speeded naming tasks (Denckla & Rudel, 1976; Korhonen, 1991; Korkman & Hakkinen-Rihu, 1994; Wolf, 1986; Wolf & Obregon, 1992.)

Purpose of the Current Project

The purpose of this study is to determine the ability of the PASS Scales of the Cognitive Assessment Scale and selected subtests of the NEPSY to differentiate between two AD/HD subtypes: AD/HD-I and AD/HD-C. This study is concentrating on planning, attention and language differences between the two AD/HD subtypes. The current study will address the following research hypotheses.

Research Hypotheses

Set One: Group Comparisons of the NEPSY

1. It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Tower subtest of the NEPSY .

2. It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the number of omission errors on the Auditory Attention and Response Set of the NEPSY.

It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Phonological Processing subtest of the NEPSY.

It is not predicted that the other selected subtests from the NEPSY will significantly differentiate between the AD/HD-I and AD/HD-C groups.

Set Two: Group Comparisons of the CAS

It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Planning Scale of the CAS

It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Attention Scales of the CAS

It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Successive Scale of the CAS.

It is not predicted that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Simultaneous Scale of the CAS or the three subtests of the SCAN.

CHAPTER III

METHODS

The current investigation is one of several studies within a larger, multidisciplinary master project conducted at Texas Woman's University. An introduction to the participants, instruments and procedures of the master project is given.

Description of Master Project

Participants for the master project were volunteers for the ADD/ADHD/CAPD Research Project . The goal of the Master Project is to conduct a series of ongoing studies designed to aid in the differential diagnosis of AD/HD and CAPD and identification of appropriate therapeutic interventions. The pilot project of this series was a collaborative venture between the psychology and audiology departments, aimed at delineating the relationship between the two disorders in elementary age children.

Master Project Participants

Participants consisted of 166 children and their parents or legal guardians. Participants were solicited from advertisements in Dallas-Fort Worth area newspapers and parenting magazines, physician referral and responses to project brochures. The investigation targeted children between the ages of 8 and 11 years of age with a preexisting diagnosis of CAPD and/or AD/HD.

Rationale for the age criteria was based on several factors. These include findings of: a high incidence of ADHD referral reported for this age group (Riccio, 1993), the

increased diagnosis of Central Auditory Processing pathology with increased age (Keith, 1988) and the higher incidence of identifiable CAPD symptoms that become evident as children progress beyond the earlier grades into the more auditorily challenging and diminished multisensory environment of the third or fourth grade (Keith & Stromberg, 1985). Available norms for instruments used in the Master Project also imposed age limitations for the current study. A final consideration in the selection of this age range was the developmental maturation of the Central Auditory Nervous System (CANS). Under normative conditions, the CANS is assumed to fully mature between the ages of 10-12 years such that normed scores on audiometric central auditory processing tests are generally considered valid for children ages 7 and older; whereas, adult norms may be more appropriate for children 12 years and older (Keith, 1986).

Master Project Instruments

The following instruments were administered to children in the Master Project: Woodcock-Johnson Tests of Cognitive Ability-Revised (WJR); Screening Test for Auditory Processing (SCAN); Receptive One Word Picture Vocabulary Test (ROWPVT); Attention/Executive Function and Language Domain tests from the NEPSY; Cognitive Assessment System (CAS); Wechsler Individual Achievement Test - Screener (WIAT) and Behavior Assessment System for Children-Self Report of Personality (BASC-SRP). In addition, audiometric tympanograms, pure tone thresholds and masking level difference measures were obtained.

Prior to testing all parents participated in an initial telephone intake to verify CAPD and AD/HD diagnostic status, according to the American Psychiatric Association Diagnostic and Statistical Manual of Mental Disorders (4th ed.) (DSM-IV) and

compliance with selection criteria (See Appendix B). Parents completed the following instruments during the scheduled psychology testing session: Behavior Assessment System for Children-Structured Developmental History (BASC-SDH) and Parent Rating Scale (BASC-PRS); Attention Deficit Hyperactivity Disorders Test (ADHD-T); Attention Deficit Disorders Evaluation Scale-Home Version (ADDES-H); Attention Rating Scale with accompanying demographic questionnaire; Parenting Stress Index (PSI) and Parent/Child Relationship Index (PCRI). In addition, parents were asked to give the Behavior Assessment System for Children-Teacher Rating Scale (BASC-TRS) and Attention Deficit Disorder Evaluation Scale-School Form ADDES-S) to the teacher of their choice for completion.

Master Project Inclusion Criteria

Attempts were made to detect and exclude children of limited intellectual functioning during the parent telephone screening. Participation was also limited to children free of other major handicapping conditions, such as serious motor impairment, severe articulation disorder or permanent peripheral hearing loss. Current hearing status was confirmed by a tympanogram and pure tone audiometric assessment conducted by the TWU audiology department. Children were required to be free of stimulant medication at the time of both audiometric and psychological testing. To further control for confounding variables, English as a primary language was required of all child participants.

Master Project Procedures

Children meeting research criteria based on parental responses to the telephone screening were selected for participation according to their ability to schedule during

available Master Project appointments. Psychology testing was conducted at the TWU Denton campus or at satellite Dallas test centers on either the TWU Parkland or Presbyterian campuses. All audiometric testing was conducted at the TWU Denton campus. Informed consent was obtained from the parent/legal guardian and child participant prior to onset of the first test session (See Appendix C). A \$20.00 fee was charged to offset the cost of test materials and increase motivation for attendance at both testing sessions. Fees were paid prior to the psychological testing session.

Psychological assessments typically involved testing approximately three to four children simultaneously. Data collection was partitioned among multiple investigators at separate test stations, each responsible for collection of specific dependent measures. A rotation system served to provide multiple, frequent rest breaks of brief duration to child participants. The psychology research team was comprised of doctoral level graduate students involved in psychological data collection for the Master Project, each investigating subcomponents of the data. Hearing levels, tympanograms and masking level differences were obtained by supervised graduate level trainees in the TWU audiology and speech-language pathology Communication Disorders programs. The auditory processing subtests of the SCAN were administered by the communication disorders testing team during the early phase of the investigation. However, this task was assumed by the psychology testing team during the final months of the Master Project in order to expedite a more timely collection of the data.

Testing was predominantly conducted over the course of two sessions. The psychological testing was administered during one session while testing for audiometric and auditory processing were administered concurrently in a separate session.

Administration time for psychological testing was approximately 4.5 hours; administration time for audiometric and auditory processing testing was approximately one hour. Parents received a brief summary of their child's test performance and were given the opportunity for additional debriefing during group feedback sessions with investigators.

Description of the Current Project

Current Project Participants

Participants in this study consisted of 118 (71.08%) of the 166 children who participated in the Master Project. Forty-eight children (28.91%) were excluded on the examination of the CAS and NEPSY data. Two children (1.2%) were excluded because of age, ten (6.02%) were excluded because of incomplete data and 36 (21.68%) because they did not qualify for this study based on their scores on the ADDES. A separate grouping was used for the examination of the SCAN data. Participants consisted of 84 (71.19%) of the 118 children who participated in the Current Project. Thirty-four children (28.81%) were excluded from this analysis. Seventeen (14.41%) of the children were excluded because of incomplete data, three (2.54%) due to the diagnosis of a selective hearing impairment during audiometric assessment and fourteen children (11.86%) obtained abnormal tympanogram readings.

Instruments of the Current Project

The instruments that were utilized in the Current Project were as follows:

1) Attention Deficit Disorders Evaluation Scale-Home Version (ADDES-H), 2) NEPSY, A Developmental Neuropsychological Assessment, 3) Screening Test for Auditory Processing Disorders (SCAN), 4) Cognitive Assessment System (CAS) and 5) the

Behavior Assessment System for Children-Structured Developmental History (BASC-SDH).

Attention Deficit Disorders Evaluation Scale-Home Version, Second Ed. (ADDES-H)

The ADDES-H provides information to facilitate the diagnosis and classification of attentional disorders (McCarney, 1995). It is a 46-item instrument designed to provide a comprehensive measure of a child's attentional behaviors at home and in public settings as reported by parents. Each of the items on the ADDES-H is rated on a 5-point frequency scale, ranging from "*does not engage in the behavior*" to "*one to several times per day.*"

The ADDES-H yields two subscales referred to as *Inattentive* and *Hyperactive-Impulsive* which are comparable to DSM-IV diagnostic criteria for ADHD and yield Raw Scores which are converted into Subscale Standard Scores. These *Inattentive* and *Hyperactive-Impulsive* Subscale Standard Scores are combined to yield a Percentile Score, which incorporates age and sex characteristics of the child. The Sum of the Subscale Standard Score has a mean of 10 and standard deviation of 3. Children with attentional ratings of 7-13 are considered statistically average, while those reflecting scores below 7 are considered statistically abnormal and are indicative of ratings one or more standard deviations below the mean of the normative sample.

In addition, the sum of subscales standard scores below 4 are indicative of ratings two or more standard deviations below the mean of the normative sample and are a serious concern (McCarney, 1995). The ADDES-H was normed on 2,415 children, ages 3-19 from 23 states with and without diagnoses of AD/HD (McCarney, 1995).

Reliability

The reliability coefficients for the ADDES-H were calculated using the Kuder-Richardson 20 formula. The *Inattentive* and *Hyperactive-Impulsive* subscales had values greater than .95 on internal consistency with the interrelationship of the subscales being .77 (McCarney, 1995). Test-retest reliability was computed on 148 subjects from the normative sample with a 30 day time interval between test administrations. Results for males and females at each age, according to McCarney (1995), ranged from a minimum coefficient of .88 (16-18, males) to a maximum coefficient of .93 (16-18 females). Interrater reliability for the ADDES-H is strong with an average correlation of $r = .82$ ($p < .01$). One hundred seventy-two sets of parents rated their child's behavior. Their results were calculated using the Pearson Product-Moment Correlation and yielded ratings that ranged from .80 to .84 for all ages (McCarney, 1995).

Validity

The ADDES-H's validity coefficients are exceptionally strong. The content and construct validity demonstrates excellent diagnostic validity and ability to identify children with AD/HD. Each of the defined subscales was analyzed by factor analysis using the principal components method for extracting factors and a varimax criterion for rotation of factor axes. Both had 3 eigenvalues greater than 1.0; however, in each case, the dropoff between the first and subsequent eigenvalues was large enough to indicate an interpretation of a single dominant factor. Raw Score mean differences between the two groups were statistically significant ($p < .001$) for all subscales and the percentile. This strong construct validity and the criterion-related validity indicated by the comparison of the ADDES-H to other scales indicates that the ADDES-H has strong diagnostic validity

for the stated purpose of identifying Attention-Deficit/Hyperactivity Disordered children and youth.

The correlation of the subscales for the ADDES-H has a significant correlation of .769, which is significant at that level, indicating that all the subscales measure the construct of Attention-Deficit/Hyperactivity Disorder. Criterion related validity was determined by the comparison of the ADDES-H with several other instruments that measured AD/HD. For example, compared subscales yielded coefficients exceeding the .01 level of confidence in correlation with subscales on the Conners' Parents Rating Scale.

Screening Test for Auditory Processing Disorders

The Screening Test for Auditory Processing Disorders (SCAN) is a comprehensive instrument for evaluation of auditory development in children from ages 3-11 (Keith, 1986). It is well standardized and the most commonly used non-physiological measure of central auditory processing disorder (Chermak, Traynham, Seikel, & Musiek, 1998). The SCAN was created to aid in the identification and diagnosis of children with auditory processing and receptive language disorders and in associated intervention and treatment planning. In addition, the SCAN assesses auditory maturation as an indication of central auditory nervous system functioning (CANS). The SCAN is composed of tape-recorded tasks that can be administered in approximately 20 minutes and requires the use of a high fidelity stereo cassette player and a quality headphone set. The SCAN yields both a Composite Score, with a mean of 100 and standard deviation of 15, and individual subtest scores, with a mean of 10 and standard deviation of 3. Higher scores are indicative of positive performance on auditory

processing tasks. The SCAN is composed of three subtests chosen for their significance to auditory functioning abilities. The subtests are as follows: Filtered Words (FW), Auditory Figure Ground (AFG) and Competing Words (CW).

Filtered Words (FW) is considered an auditory closure task and assess the ability of an individual to comprehend lower acoustic signals such as might occur with poor quality audio recordings or distorted speech. Poor performance on this task may be indicative of a receptive language dysfunction. FW is made up of 20 monosyllabic words that are low-pass filtered at 1000 Hz, with a filter roll-off of 32 dBs per octave. This creates a distorted effect by deleting the high frequency signals (Keith, 1986). Each child is administered two practice trials for each ear. The first trial is delivered to the right ear and the child is to repeat the words. This process is then repeated for the left ear. An inaccurate response is scored if the child omits or substitutes a word.

The Auditory Figure Ground (AFG) task measures a child's ability to discriminate speech in the presence of competing background noise. The AFG consists of 20 undistorted monosyllabic words recorded with a background "speech babble" at 8dB speech-to-noise ratio (Keith, 1986). Under these conditions no single background words are distinguishable. The noise and words are presented to the right ear first and followed by left ear presentation. Defective comprehension under these conditions is considered a possible developmental delay of the auditory system (Keith, 1986).

The competing words (CW) task is a dichotic listening task for the assessment of auditory maturation. CW is composed of two 25 monosyllabic word-pair lists presented simultaneously to both ears. The word-pairs consist of semantically unrelated words matched within 5 milliseconds for equal presentation (Keith, 1986). Initially a list of

word-pairs is presented to both ears simultaneously. The child is to repeat both words beginning with the word administered to the right ear. During the second trial, a different list of word-pairs is presented to both ears simultaneously, and the child is to repeat both words beginning with the word administered to the left ear. The CW task produces right and left ear advantage scores based on differential performance on the task.

NEPSY - A Developmental Neuropsychological Assessment

The NEPSY is a comprehensive instrument designed to assess neuropsychological development in pre-school and school-age children across five functional domains. These include: (1) Attention/Executive Functions; (2) Language; (3) Sensorimotor Functions; (4) Visuospatial Processing; and (5) Memory and Learning (Korkman, Kirk, & Kemp, 1998). The NEPSY is based on the Lurian theory of assessment of adults with acquired brain damage (Christensen, 1984; Luria, 1973, 1980).

This model describes cognitive functions as composed of three flexible and interactive units hierarchically arranged such that if one component of a function is impaired, then the complex cognitive functions to which it contributes may also be impaired. Therefore, the basic principle that underlies the Lurian theory is to identify the primary deficits underlying impaired performance in one functional domain that affect performance in other functional domains (secondary deficits; Korkman, 1995).

The NEPSY was standardized on a sample of 1,000 cases and included 100 children in each of 10 age groups ranging from 3-12 years. The sample included 50 males and 50 females in each group (Korkman et al., 1998). The NEPSY was standardized with a stratified random sampling of children that was representative of the U.S. population of children according to the 1995 U.S. Bureau of the Census.

The NEPSY is divided into four subtests – Tower, Auditory Attention and Response Set, Phonological Processing, and Speeded Naming. Each of the four subtests has a mean of 10 and standard deviation of 3. The sum of the subtests in each domain yields a Core Domain Score with a mean of 100, with a standard deviation of 15 and a Percentile Score based on age and gender.

The selected subtests that measure attention/executive functions include: (1) Tower, which measures the executive functions of planning, monitoring, self-regulation, and problem solving; and (2) Auditory Attention and Response Set - a continuous performance test which is divided into two parts. Part A assesses the child's vigilance and maintenance of selective attention, and Part B assesses the child's ability to shift set, maintain a complex mental set and regulate responses to contrasting and matching stimuli. The NEPSY subtests that measure language include: (1) Phonological Processing, which is also divided into two parts. Part A measures the ability to identify words from orally presented word segments (auditory gestalt), and Part B measures phonological segmentation with letter sounds and word segments; and (2) Speeded Naming, which measures the ability to access and produce familiar words rapidly.

Reliability

Reliability coefficients for the NEPSY were calculated through split-half, test-retest, and generalizability procedures, depending upon the nature of the subtest (Korkman et al., 1998). Internal consistency reliability coefficients were derived by partitioning the subtest into two halves that were equal in length and were approximate parallel forms. Raw scores were computed for performance on each half and correlated with one another. The derived Pearson Correlation Coefficient was then corrected for

length of the test using the Spearman-Brown formula (Crocker & Algina, 1986).

Concerning the tests involved in the Current Project, the overall reliability coefficients for the Tower and Auditory Attention and Response Set subtests for ages 5-12 are both .82. For Phonological Processing and Speeded Naming subtests, the overall reliability coefficients are .91 and .74 respectively.

Validity

Validation of the NEPSY has been extensive with regard to content, construct and criterion related validity. Additionally data exists on the sensitivity of the NEPSY on several clinical diagnostic groups. With respect to criterion related validity, NEPSY subtests significantly correlated with specific LD and ADHD diagnoses. Content validity was performed using other tests as well as panels of experts and reviews of research studies. Content validity studies indicated that NEPSY subtests adequately represented the behaviors that the subtests were intended to measure. Specifically, the performance of children with AD/HD as compared to matched controls indicated that AD/HD children performed significantly less well on the individual subtests of Tower and Auditory Attention and Response Set. A significant discrepancy was also noted on the Phonological Processing subtest; however, there was not a significant discrepancy between the AD/HD children and matched controls on the Speeded Naming subtest. Construct validity was performed on the NEPSY through comparison studies using tests of general cognitive ability, achievement and neuropsychological functioning.

The Cognitive Assessment System

The Cognitive Assessment System (CAS) is also based on the Lurian tradition. The Das-Naglieri CAS is an operational model of Luria's Theory. Within the concept of

hierarchical functional units previously discussed, the Lurian model proposes a four-factor model of cognitive processing: Planning (P), Attention (A), Simultaneous (S) and Successive (S) (Luria, 1973). These processes are also known as the PASS Model. The four areas of the PASS Model comprise the four scales of the CAS, which are designed to assess cognitive processing in children 5-17 years of age.

Standardization of the CAS was obtained by stratified, random sampling to approximate the 1990 U.S. census data with regard to sex, race/ethnicity and parental education. Data was collected over a three-year period from 68 sites across the United States. The normative sample was made up 1,100 male and 1,100 female children ages 5-17 from both regular and special education settings (Das, Naglieri, & Kirby, 1994).

The CAS is composed of three scales: The Full Scale, the PASS cognitive processes and the six individual subtests. The Full Scale and PASS scales have a mean of 100 and a standard deviation of 15. The Full Scale is a total of the four PASS scales and indicates the child's overall level of cognitive functioning. Each Pass Scale is composed of two subtests that each have a mean of 10 and a standard deviation of 3. Subtest raw scores are converted to scaled scores according to age range (Naglieri & Das, 1997).

The Planning factor consists of the following subtests: (1) Matching Numbers - a measure of executive function involving problem solving and visual motor attention and concentration; and (2) Planned Codes - a measure of executive function that involves planning and problem solving. The Attention factor is made up of the following subtests: (1) Expressive Attention, which assesses ability for selecting and shifting attention while inhibiting impulsive expressive responses; and (2) Number Detection, which also

assesses ability to select and shift attention and vocalize proper expressive responses while resisting distractions.

The Simultaneous Processing factor consists of the following subtests: (1) Nonverbal Matrices, which assesses part-to-whole abstract reasoning and spatial visualization skills; and (2) Verbal Spatial Relations, which assesses the understanding of logical and grammatical relationships. The Successive Processing factor consists of the following subtests: (1) Word Series, which assesses memory for non-meaningful simple verbal material; and (2) Sentence Repetition, which assesses memory for non-meaningful complex verbal material.

Reliability

Reliability coefficients for the CAS Basic Battery and Full Scale were calculated using the linear combination, reliability formula. Average reliability coefficients were calculated using the Fisher's z-transformation across all age groups. The average reliability coefficient for the Full Scale of the CAS Basic Battery is .87 (Naglieri & Das, 1997). The reliability coefficients for the Successive and Simultaneous scales were both .90 and were obtained using the split-half method and corrected using the Spearman-Brown formula (Naglieri & Das, 1997). Reliability coefficients for the Planning and Attention scales were .85 and .84 respectively and were obtained using test-retest reliability because these subtests incorporate a timing component.

Validity

Preliminary validity studies are currently under investigation; however some initial findings are available. Construct validity was obtained by calculating the raw scores for the entire standardization sample across age groups. Results indicated that the

CAS subtest scores appropriately changed with respect to maturation (Naglier & Das, 1997). Content Validity was obtained by the use of task analysis and experimental examination to best represent the PASS processes proposed by Luria. Re-analysis of the author's original standardization sample indicated that the Planning and Attention scales of the CAS were highly interrelated (Naglieri & Das, 1997; Kirby, 1994).

Behavior Assessment System for Children–Structured Developmental History

The Behavior Assessment System for Children-Structured Developmental History (BASC-SDH, Reynolds & Kamphaus, 1992) is an in-depth parent/legal guardian questionnaire covering developmental history and family background. Parents provide social, psychological, developmental, educational and medical information pertinent to the assessment process.

Procedures of the Current Investigation

As described previously, the Current Project is one of several studies within a larger, multidisciplinary project. Only procedures and instrumentation relevant to the Current Project will be presented here. An initial telephone intake was given to all parents to verify DSM-IV, AD/HD diagnostic status and compliance with selection criteria prior to testing. A screener of DSM-IV diagnostic criteria was given orally to the parents and their responses were recorded. If the child fulfilled the diagnostic criteria, a date was set for testing.

During psychological testing, which included the NEPSY and the CAS, three to four children were tested simultaneously with counterbalancing to control for carryover effects. The children were also given breaks to control for fatigue. Prior to psychological testing, audiological testing and the SCAN were individually administered

to screen for hearing deficits and provide auditory processing measures. While the children were being tested, parents were asked to complete the Attention Deficit Disorders Evaluation Scale-Home Version, Second Edition (ADDES-H) and the Behavioral Assessment System for Children-Structured Developmental History (BASC-SDH).

Audiometric performance criteria were based on bilateral hearing level performance between 500 and 4000 Hz. Pure tone averages at 500, 1000 and 2,000 Hz were calculated for each ear. Only children with hearing levels falling in the normal range, i.e. -10dB to +15dB, were included in the sample. Within normal limits bilateral tympanogram readings were defined by the following three categories: pressure measures; falling between -150 and +125daPa; and Type A shape and compliance measures within .25 to 2.8 cm. Because the validity of SCAN results are questionable for children performing below audiometric thresholds, data from these children were subsequently eliminated from the Current Project. Participants were divided into groups of AD/HD-I and AD/HD-C based on the results of the ADDES-H screener completed by the parents.

Data Analysis

This study utilized binary logistical regression analysis to assess the ability of the CAS and NEPSY subtests to distinguish between the two subtypes of AD/HD (AD/HD-I and AD/HD-C), while controlling for differences in age and gender. A t-test for independent variables was performed to determine if there are significant differences between the two groups with respect to the number of omissions on Part A and Part B of the Auditory Attention and Response Set. Additionally, a binary logistic regression

analysis was performed to assess whether there were significant differences between the two groups on the subtests of the SCAN, when controlling for age and gender.

CHAPTER IV

RESULTS

The results of this study are presented in three sections. The first section provides a demographic description of the participants for each subtype of AD/HD. Demographic information is also provided regarding the parents as well as information concerning the participants' medical history. The second section provides the results from the multivariate analyses to test the hypotheses corresponding to the NEPSY and CAS. The third section provides the results of a multivariate analysis to test the hypotheses corresponding to the SCAN.

Demographic Description of Participants

Table 1 presents a demographic profile of those who participated in the current study ($n = 118$). Complete demographic information was not available for all of the subjects in the study. The demographic results are presented by AD/HD subtypes to provide a comparison between the two groups.

The demographic information revealed that the majority of subjects included in the study were males. The results also indicated that the percentage of female subjects varied significantly between the two AD/HD groups ($\chi^2 = 4.881, p < .05$). Less than 30% of the AD/HD-I group were female; whereas, over 45% of the AD/HD-C group were female. The results of the study showed that the ages of the subjects in both groups ranged from 7.9 to 11.12 years of age. Approximately 90% of each group were Caucasian with a small percentage of minorities represented in each group.

Table 1

Demographic Characteristics for AD/HD-I and AD/HD-C Groups

Demographic	AD/HD-I		AD/HD-C	
	N	Percent	N	Percent
Ethnicity				
Caucasian	27	90.01	49	90.74
African-American	1	3.33	4	7.41
Other	2	6.66	1	1.85
Total	30	100.00	54	100.00
Gender				
Male	29	70.70	42	54.50
Female	12	29.300	35	45.50
Total	41	100.00	77	100.00
Grade				
2 nd	4	13.79	1	1.89
3 rd	6	20.69	13	24.53
4 th	9	31.04	17	32.07
5 th	6	20.69	13	24.53
6 th	4	13.79	9	16.98
Total	29	100.00	53	100.00
Age*				
8	12	29.27	16	20.78
9	8	19.51	27	30.06
10	14	34.15	19	24.68
11	7	17.07	15	19.48
Total	41	100.00	77	100.00
<u>Note:</u> *Mean Age	9.8		9.9	

The demographic information for the parents of a subset ($n = 86$) of the subjects is presented in Table 2. The data revealed that the majority of the children in this current study came from upper income families. Approximately 53% of children in the

AD/HD-I group and 71% of children in the AD/HD-C group came from families with incomes in excess of \$59,000.00. Additionally, almost 50% of both mothers and fathers in each group had a Bachelor's Degree or higher.

Table 2

AD/HD Parent Demographic Characteristics

Demographic	AD/HD-I		AD/HD-C	
	N	Percent	N	Percent
Father's Education				
< High School	0	0.00	2	3.63
High School or GED	8	25.81	15	27.27
2 Year Associate	8	25.81	12	21.82
4 Year Bachelors	8	25.81	16	29.10
Masters	6	19.35	8	14.55
Doctorate	1	3.22	12	3.63
Total	31	100.00	55	100.00
Mother's Education				
< High School	2	6.45	1	1.82
High School or GED	4	12.91	14	25.45
2 Year Associate	11	35.48	13	23.64
4 Year Bachelors	11	35.48	21	38.18
Masters	3	9.68	6	10.91
Doctorate	0	0.00	0	0.00
Total	31	100.000	55	100.00
Family Income				
\$15,000-\$28,999	1	3.33	9	16.36
\$29,000-\$44,998	2	6.66	3	5.46
\$44,999-\$58,999	11	36.67	4	7.27
\$59,000-\$74,999	6	20.00	14	25.46
\$75,000-\$84,999	3	10.00	11	20.00
\$85,000-\$98,999	2	6.67	5	9.09
\$99,000-\$100,000	5	16.67	9	16.36
Total	30	100.00	55	100.00

In addition, Information regarding selected aspects of the children's medical history was reported by a subset of the parents ($n = 94$) and are presented in Table 3.

Table 3

AD/HD Group Medical History

Demographic	AD/HD-I		AD/HD-C	
	N	Percent	N	Percent
Tubes				
No Tubes	24	66.67	47	65.28
Tubes	11	30.56	18	25.00
Frequent Ear Infections	1	2.77	7	9.72
Total	36	100.00	72	100.00
Anxiety				
No	40	97.56	77	97.47
Yes	1	2.44	2	2.53
Total	41	100.000	79	100.00
Depression	39	95.12	70	88.61
No	2	4.88	9	11.39
Yes				
Total	41	100.00	79	100.00
Stimulant Medication				
No	22	64.71	21	35.00
Yes	12	35.29	39	65.00
Total	34	100.00	77	100.00

The data revealed that approximately 32% of the AD/HD-I group and 25% of the AD/HD-C group had tubes in their ears because of recurrent ear infections. Additionally, more than 2% of AD/HD-I and 9% of AD/HD-C children reportedly suffered from frequent ear infections, but never required tubes. Parents reported that approximately 3% of the children in both the AD/HD-I and AD/HD-C suffered from anxiety. Additionally, 5% of the AD/HD-I group and 11% of the AD/HD-C group reportedly suffered from depression. One-third of children with AD/HD-I and two-thirds of those with AD/HD-C were on stimulant medication.

An analysis of the AD/HD groups as determined by the ADDES and DSM-IV criteria was conducted to verify the concurrent validity of the ADDES and its utility for identifying subtypes of AD/HD. A binary logistic regression was used to compare the groups as defined by the two strategies and the results indicated that the ADDES groups were similar to those defined by the DSM-IV ($\chi^2(3) = 32.56, p < .001$). Therefore, the study proceeded using the AD/HD groups as defined by the ADDES.

Hypotheses One and Two: Group Comparisons of the NEPSY and CAS

Table 4 is a display of the results of a binary logistic regression analysis comparing the means of the AD/HD-I and AD/HD-C groups for select subtests of the NEPSY and the four scales of the CAS. These hypotheses predicted that there would be significant differences between the AD/HD-I and AD/HD-C groups on the Tower and Phonological Processing subtests of the NEPSY and the Planning, Attention and Successive Scales of the CAS. Additionally, it was predicted that there would not be a significant difference between the AD/HD-I and AD/HD-C groups on the Auditory Attention and Response subtest and the Speeded Naming subtests of the NEPSY as well as the Simultaneous Scale of the CAS.

A goodness-of-fit test for the model showed that the subtests as a whole significantly discriminated between the AD/HD-I and AD/HD-C groups, $\chi^2(10) = 17.99, p < .05$. Binary logistic regressions coefficients (B) and log odds ratio (OR) statistics are provided for each of the NEPSY and CAS subtests in the model. The results of the analysis indicated that the groups scored significantly different on the Planning Scale of the CAS ($b = .10, p < .01$), with AD/HD-C group tending to have higher scores than the AD/HD-I group. There were also significant differences between the AD/HD-I and the

AD/HD-C groups on the Tower subtest of the NEPSY ($b = -.22$, $p < .05$). The AD/HD-C group tended to have lower scores than the AD/HD-I group on this subtest.

Table 4

Binary Logistic Regression Analysis of Selected Subtests of the CAS and NEPSY

Test	Variable	Beta	OR
CAS	Planning	.10*	1.10
	Attention	-.01	.98
	Simultaneous	.046	.96
	Successive	.02	1.02
NEPSY	Tower	-.22**	.79
	Auditory Attention	-.02	.97
	Phonological Processing	.04	1.04
	Speeded Naming	.01	1.01
	Gender	.66	1.94
	Age	-.15	.86
	Intercept	1.74	
	$\chi^2 (10)$	17.9*	

Note: AD/HD-I ($n=41$) was the comparison group; AD/HD-C ($n = 77$) was the test group
 $p < .05$, two-tailed. ** $p < .01$, two-tailed.

The results of this analysis also revealed that there were no significant difference between the groups on the Auditory Attention and Response and Speeded Naming subtests of the NEPSY as well as the Simultaneous Scale of the CAS. The analysis indicated that there were no significant differences between the groups with respect to the

Phonological Processing subtest of the NEPSY and the Successive Scale of the CAS.

A subsequent binary logistic regression analysis was performed on the two subtests of the Planning scale (Planned Codes and Memory for Numbers) to determine the relative contribution of each of the two subtests. The results indicated that the groups did not score significantly different on either of the subtests ($\chi^2(2) = 5.69, p > .05$).

In addition, an Independent Sample T-Test was conducted to assess for differences in the number of omissions on Part A and Part B of the Auditory Attention and Response subtest of the NEPSY. This analysis indicated that there was no significant difference between the AD/HD-I and AD/HD-C groups with regard to number of omissions on Parts A and B of the Auditory Attention and Responses subtest (Part A, $t = 1.16, p > .05$; Part B, $t = .20, p > .05$).

Group Comparisons of the SCAN

Table 5 presents results from analyses that examined the SCAN hypotheses when controlling for age and gender. This set of hypotheses predicted that there would not be significant differences between the AD/HD-I and AD/HD-C groups on the Filtered Words, Auditory Figure Ground and the Competing Words subtests of the SCAN. Results of the binary regression analysis indicated that there were no significant differences between the groups on any of the subtests of the SCAN ($\chi^2(5) = 3.17, p > .05$). These findings supported the hypotheses as outlined above.

Table 5

Results of the Binary Regression Analysis for AD/HD Subtypes on the SCAN

Test	Variable	Beta	OR
SCAN			
	Filtered Words	-.0207	.98
	Auditory Figure-Ground	.04	1.04
	Competing Words	.018	1.02
	Gender	-.07	1.0768
	Age	.066	.06
	Intercept	1.64	
	χ^2 (5)	3.2	

Note: AD/HD-I ($n=32$) was the comparison group; ADHD-C ($n=44$) was the test group)

Summary

The results of this study revealed that there were significant differences between both the AD/HD-I and the AD/HD-C on both the Planning Scale of the CAS and the Tower subtest of the NEPSY as was hypothesized. No significant difference was expected to be found between the AD/HD-I and AD/HD-C groups on the Simultaneous Scale of the CAS or the Speeded Naming and Auditory Attention and Response Set of the NEPSY.

It was hypothesized that the Phonological Processing subtest of the NEPSY and the Successive Scale of the CAS would also indicate significant differences between the two AD/HD groups; however, no significant difference was found between the AD/HD-I and AD/HD-C groups on these two subtests. Additionally, no significant difference was

found on the number of omissions on the Auditory Attention and Response Set as was predicted. These results are presented in Appendix D.

CHAPTER V

DISCUSSION

This study examined the ability of the NEPSY and the CAS to differentiate between the AD/HD-I and AD/HD-C subtypes of AD/HD. Additionally, the SCAN was administered to screen for children with auditory processing difficulties which could affect scores on the subtests. The SCAN was also used to detect any auditory differences between the AD/HD-I group and the AD/HD-C group. This information was especially important in light of the demographic information indicating that a significant percentage of children with AD/HD suffer from multiple ear infections resulting in the need for tubes in their ears.

In general, the findings of this study support the ability of the NEPSY and the CAS to differentiate between AD/HD-I and AD/HD-C with regard to executive functioning and planning. Results involving attention and language functioning of the two groups were inconclusive. This discussion will mainly focus on each of the two main sets of hypotheses regarding differences between AD/HD-I and AD/HD-C subtypes on the NEPSY and CAS and present some possible explanations for this study's results. Additionally, some areas for future research which might produce more definitive results will be addressed.

Findings on the NEPSY indicated a significant difference on the Towers subtest, but no significant differences were found on the other three subtests of the NEPSY;

however, mean scores of all subtests were consistent with previous findings of Korkman, Kirk, & Kemp (1998) who compared AD/HD children in general with normal controls. These results indicated that children with AD/HD-I had higher mean scores than children with AD/HD-C on all selected NEPSY subtests except Speeded Naming, although there was not a significant difference. Additionally, on an examination of the number of omission errors made by each group on the Auditory Attention and Response Set, no significant differences were found between the number of omissions in Part A and Part B for the AD/HD-I and AD/HD-C groups.

The CAS results indicated a significant difference between the two subtypes on the Planning Scale, but in an unexpected direction. No significant differences were found between the AD/HD-I and AD/HD-C groups on the remaining scales of the CAS.

Results of the SCAN analysis reported no significant differences between the AD/HD-I and AD/HD-C groups on any of the three SCAN subtests. Chermak et al. (1998) concluded that children with AD/HD would exhibit a high level of performance on all SCAN subtests as opposed to children with Central Auditory Processing Disorder. Children with CAPD were expected to perform poorly on the Auditory Figure-Ground subtest and highly on the other two subtests, or to perform well on the Filtered Words and Auditory Figure Ground subtests with poor performance on the Competing Words subtests. This study's findings on the SCAN were consistent with Chermak et al.'s research. The AD/HD-I and AD/HD-C subtypes both scored average or above average on all subtests of the SCAN. Therefore, it appears the AD/HD sample used for this research did not have auditory processing deficits as identified by the SCAN.

Theories of Planning and Attention

In general, this study looked at the concepts of planning, attention and language functioning of children with AD/HD-I or AD/HD-C. Results indicated that the CAS and the NEPSY were able to differentiate between the two AD/HD groups on tests of executive functioning and planning, but not on attention and language tasks.

Barkley's (1998) theory, which postulated that AD/HD is a function of problematic executive functioning resulting from a deficit in frontal lobe functioning, was also examined. Barkley believed that children with AD/HD were unable to monitor and inhibit their responses to external stimuli, and were therefore impulsive. The PASS model based on Luria's theory of brain functioning is complementary to Barkley's theory. The PASS model proposes that planning, which is an executive function, is monitored by Luria's third functional unit, or the frontal lobe.

Barkley (1998) additionally reported that attention problems, as seen in children with AD/HD-HI were secondary to disinhibition. The attentional difficulties of these AD/HD children, according to Barkley, are related to lack of persistence and distractibility. On the other hand, Barkley believes that the attention problems of children with AD/HD-I are related to a deficiency in focused or selective attention.

Both the NEPSY and the CAS provided subtests which they consider measures of executive functioning, the Tower and Planning Scale, respectively. Additionally, both instruments contain measures of what they define as attention. These included the Auditory Attention and Response Set of the NEPSY and the Attention Scale of the CAS. According to the PASS Scales and Barkley's theory, if the difficulties of children with

AD/HD-I and AD/HD-HI involve separate mechanisms, then the AD/HD-I group should have lower scores on the attention measures related to selective attention and the AD/HD-C should have lower scores on executive functioning tasks and measures of attention that incorporate lack of persistence and distractibility.

Significant differences were found on the Tower subtest of the NEPSY and the Planning Scale of the CAS. Both of these subtests are purported to test executive functioning; however, the AD/HD-C group scored higher on the Planning scale of the CAS and lower on the Tower subtest of the NEPSY. Therefore, on the Tower subtest, the AD/HD-I and AD/HD-C groups performed as predicted by Barkley's theory. However, the significant difference on the Planning Scale differed directionally from what was expected and supported by Naglieri and Das (1990) and Barkley (1998).

One possibility for these findings on the CAS may be provided by Carroll (1995) who proposed that Das, Naglieri and Kirby (1994) did not demonstrate that the tests, which make up the Planning Scale, tested only planning. Carroll believed that the Planning Scale could be better described as a measure of perceptual speed. For example, both the Planned Codes and the Matching Numbers subtests, which make up the Planning scale, involve the number of responses completed in a specific time period. Das and Dash (1983) clearly demonstrated a distinction between speed and planning in two factorial studies indicating that the Planning Scale on the CAS may not be as strong a measure of executive functioning as proposed by Naglieri and Das. Another possible reason there was not stronger evidence of differences between the AD/HD-I and AD/HD-C groups on the Planning Scale comes from the research of Naglieri, Prewett and Bardos (1989). These researchers performed a three-factor orthogonal and oblique factor

analysis on the four PASS scales and found that the first planning factor was defined by the planning tasks with significant loadings by the two attention tasks.

The Planning Scale of the CAS was further evaluated by examining the two subtests that make up the scale. These two subtests are Matching Numbers and Planned Codes. Matching Numbers involves the identification of two numbers in a row that are alike, while the Planned Codes involves the development of a strategy to record codes in a particular pattern that correspond to letters. An analysis of these two subtests indicate that neither subtest alone significantly effects the Planning Scale, but it is the interaction of the two subtests that provides the significant results.

There was no significant difference reported for the measure of attention on either the NEPSY or the CAS. No significant difference was expected on the Auditory Attention and Response subtest of the NEPSY, because the nature of the task required both executive functioning and attention. Part A of the subtest required placing a colored square in a box as instructed, which mainly requires attention. However, Part B required consciously overriding the instructions of Part A to perform a new task. Therefore, executive functioning was required. The score of the Auditory Attention and Response Set was a combination of scores from both Part A and Part B. The overall score would not have provided a significant difference between the AD/HD-I and AD/HD-C groups as both groups should have difficulty on one or the other part of the subtest.

On the Attention Scale of the CAS there was also no significant difference between the AD/HD-I and AD/HD-C groups. One possible reason for the lack of significant results may be in the nature of the attention tasks. Expressive Attention is a task that assesses the ability to select and shift attention while inhibiting impulsive

responses. Number Detection also assesses the ability to select and shift attention while resisting distractions. As found on the attention task of the NEPSY, it appears that the CAS tasks that measure attention also have a strong component of executive functioning which is described as disinhibition by Barkley and constitutes a planning function.

Theories of Language Functioning

There is a high comorbidity of language disorders among children with AD/HD. The research of Barkley, DuPaul and McMurray (1990) found that 10-54% of children with AD/HD appear to have speech problems. Barkley's (1990) research indicated that AD/HD children appeared to have more difficulty when providing explanations or confrontations requiring more organization and thought. Additionally, the literature describes children with AD/HD as being impulsive, blurting out responses and interrupting during conversations (Barkley, 1998). These difficulties of expressing themselves under pressure and responding impulsively, which are common problems of children with AD/HD, are functions of disinhibition resulting from a deficit in the frontal lobe according to Barkley (1998).

In order to understand Barkley's theory of language deficits in children with AD/HD it is important to understand the nature of language production. Zentall (1985) believed that spoken language is composed of listening, which involves the ability to ignore irrelevant messages and information and focus on important information, and also the ability to control and organize thoughts. Additionally, Bronowski (1977) proposed that the ability to inhibit and delay responses were core features in human language. Therefore, it appears that speech difficulties, especially expressive speech problems of children with AD/HD, are more related to higher-order cognitive processing involving

organizing and monitoring thinking and behavior as opposed to difficulties in speech and language per se (Barkley, 1998).

The Speeded Naming subtest of the NEPSY is a confrontational naming task, and low scores on this subtest are indicative of children having difficulty on complex tasks that require executive functioning even though they might perform adequately on straightforward attention tasks. Again, there was no significant difference between the AD/HD-I and AD/HD-C groups on this subtest. One possible reason for these findings may be a result of the poor reliability coefficients of the Speeded Naming subtest and the fact that no significant difference was found between normal controls and AD/HD children in general (Korkman, 1998).

The Successive Scale of the CAS requires the repetition of a string of words and sentences. To perform adequately on this task, a child must be able to wait until the entire sequence of words is spoken, which has been shown to be difficult for hyperactive-impulsive children. There was no significant difference found between the two groups on this Scale. One possible reason may be that in addition to disinhibition, there are strong components of both selective attention and distractibility involved in the performance of successive skills. Although there was no difference between the subtypes, the mean score of both groups was lower than normal controls and comparable to AD/HD children in general (Korkman, 1995).

AD/HD children also appear to have a significant amount of learning problems. Two language deficits that are highly correlated with learning problems in children are phonological processing and confrontational naming (Korkman, Hakkinen-Rhiu, 1994). The Phonological Processing subtest of the NEPSY assesses phonological segmentation

at the level of letter sounds and word segments. A lower score on this subtest, in the absence of an auditory acuity problem, may indicate a phonological processing problem or an attentional problem that could affect reading, spelling and learning a new language (Korkman, 1998).

The analysis of the SCAN ruled out hearing and auditory processing deficits in this sample of children; therefore, a low score on this subtest may indicate phonological or attentional difficulties. The Phonological Processing subtest also requires the subject to hear a word, remove a letter or sound and mentally replace it with another letter or sound before expressing the new word. Therefore, a strong executive function component involving distractibility and shifting set are involved in this subtest.

There is no research to suggest that AD/HD children have difficulty with simultaneous processing. Therefore, no significant difference between the AD/HD-I and AD/HD-C groups was expected. This was confirmed in the study and both groups scored comparably with normal controls (Korkman, 1998).

Limitations of the Study

One limitation of this study was the lack of AD/HD-HI subtypes. The ADDES-Home version was used to identify each subject's subtype; however, when the sample was examined, there were not enough AD/HD-HI subjects to analyze. Therefore, the sample used for this study involved only the AD/HD-I and AD/HD-C groups. The Combined Type of AD/HD is a combination of both the AD/HD-HI and AD/HD-I groups. Therefore, one reason why this study was unable to better differentiate between subtypes might be because the sample was too homogeneous.

It will be important for future research to have a more heterogeneous sample. One possible reason the sample did not include many hyperactive-impulsive children may be because of the age group tested. Research shows that as children age, symptoms of hyperactivity tend to diminish, but attention symptoms may persist into adolescence and adulthood (Biederman, Faraone, & Lapey, 1998; Millstein, Wilens, & Biederman, 1997). Achenback and Edelbrock (1995) conducted a 6-year study of male and female adolescents growing into adulthood. Their findings indicated that childhood attention problems persisted into early adulthood without the significant problems with hyperactivity-impulsivity found in early childhood. However, according to Barkley (1997) the attention problems of the AD/HD-HI group continue to be related to lack of persistence and distractibility, while the attention deficits of the AD/HD-I groups continue to involve selective or focused attention. Therefore, it may be advantageous to assess a broader age range of children and to assess specific attentional processes in order to obtain a more diversified and informative sample.

Additionally, the inclusion of a test of disinhibition such as the Test of Variable Attention (TOVA) or the Continuous Performance Test (CPT) for use as a comparison to the CAS and NEPSY executive function and attention subtests, would have provided valuable information. The CPT (Rosvold et al., 1956) and TOVA (Greenberg, 1988) have been found to differentiate between hyperactive and normal children. Although controversy exists as to the diagnostic value of these instruments, they still provide valuable information as to disinhibition and executive functioning deficits well as behavior of the subject during tests of sustained attention. Unfortunately, this study was limited by the Master Study, which did not include these tests.

In summary, possible reasons for some inconclusive results of this study include discrepancies in what the subtests are purported to test, or their construct validity, a need for a more operational definition of attention and the lack of AD/HD-HI subjects. It is also possible that a larger sample may have given more conclusive result

Future Research

Given the above discussion, future research should focus on further examination of the CAS and NEPSY subtests. More research is needed to further examine the construct validity of the subtests. For example, the controversy over the Planning Scale of the CAS should be closely examined in addition to the Speeded Naming subtest of the NEPSY. More accurate measures of executive functioning and disinhibition are needed in order to provide better information concerning frontal lobe functioning.

As well, additional measures of attention are needed to further operationalize this function. There is significant controversy in the field as to what concepts should be included in the measurement of attention. It is becoming increasingly important to accurately identify the different aspects of attention and how to measure them. Attentional problems are pervasive and lifelong. For example, researchers of the developmental theory have found that attention problems in adulthood are associated with significant impairment in employment and social relationships (Brown, 2000). Therefore, it appears that attention problems plague many people, from young children through adulthood, and these problems need to be addressed.

Future research should also include a population with strong, clear, groups of each AD/HD subtype. A more diversified sample, with regard to demographics, such as income and ethnicity should also be utilized whenever possible. Many AD/HD

assessments are mainly tested on Caucasian, hyperactive-impulsive boys. Therefore, more diversified studies are needed to expand the use of these instruments into additional populations.

It is hoped that the current project will stimulate more extensive examination of both AD/HD subtypes and the neuropsychological assessments currently available. There are many questions unanswered about AD/HD such as cognitive impairments across the life span, the interactions of genetic and environmental factors in AD/HD, specific learning disorders and AD/HD and longer-term treatment of AD/HD. As neuropsychological instruments are provided that can give a clearer picture of the mechanisms involved in AD/HD, more questions about etiology, differential diagnosis and treatment regimens will be answered. Many of these assessments are relatively new and more studies are needed to provide stronger reliability and validity measures. Additionally, it will be important for stronger and more distinct measures of attention, planning and language functioning to be developed which can be used to further examine Barkley's theory as well as other theories of AD/HD, and provide additional information as to the workings of the brain.

APPENDIX A

DSM-IV Diagnostic criteria for
Attention-Deficit/Hyperactivity Disorder

DSM-IV AD/HD CRITERIA

A. Either (1) or (2)

- (1) six (or more) of the following symptoms of **inattention** have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Inattention

- a) often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
- b) often has difficulty sustaining attention in tasks or play activities
- c) often does not seem to listen when spoken to directly
- d) often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)
- e) often has difficulty organizing tasks and activities
- f) often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
- g) often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)
- h) is often easily distracted by extraneous stimuli
- i) is often forgetful of daily activities

- (2) six (or more) of the following symptoms of **hyperactivity-impulsivity** have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Hyperactivity

- a) often fidgets with hands or feet or squirms in seat
- b) often leaves seat in classroom or in other situations in which remaining seated is expected
- c) often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)
- d) often has difficulty playing or engaging in leisure activities quietly
- e) is often “on the go” or often acts as if “driven by a motor”
- f) often talks excessively

Impulsivity

- g) often blurts out answers before questions have been completed
- h) often has difficulty awaiting turn

- i) often interrupts or intrudes on others (e.g., butts into conversations or games)
- B. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before age 7 years.
- C. Some impairment from the symptoms is present in two or more settings (e.g., at school, or work and at home).
- D. There must be clear evidence of clinically significant impairment in social, academic, or occupations functioning.
- E. The symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a Personality Disorder).

Attention-Deficit/Hyperactivity Disorder, Combined Type:

if both Criteria A1 and A2 are met for the past 6 months

Attention-Deficit/Hyperactivity Disorder, Predominantly Inattentive Type:

if Criterion A1 is met but Criterion A2 is not met for the past 6 months

Attention-Deficit/Hyperactivity Disorder, Predominantly Hyperactive-Impulsive Type: if Criterion A2 is met but Criterion A1 is not met for the past 6 months

APPENDIX B

Telephone Screening Questionnaire

ADD/ADHD SCREENING CHECKLIST

Think of your child as s/he would behave off of stimulant medication. Compare his or her behavior to that of the typical same-age child and indicate all that apply.

Inattention

- often fails to give close attention to details or makes careless mistakes in schoolwork or other activities
- often has difficulty sustaining attention in tasks or play activities
- often does not seem to listen when spoken to directly
- often does not follow through on instructions and fails to finish schoolwork, chores or other duties (not due to oppositional behavior or failure to understand)
- often has difficulty organizing tasks and activities
- often avoids, dislikes or is reluctant to engage in tasks that require sustained concentration (such as schoolwork or homework)
- often loses things necessary for projects (e.g., toys, school assignments, pencils, books)
- often easily distracted by extraneous stimuli
- often forgetful in daily activities

Hyperactivity or Impulsivity

Hyperactivity

- often fidgets with hands or feet or squirms in seat
- often leaves seat in classroom or other situations in which remaining seated is expected
- often runs about or climbs excessively in inappropriate situations
- often has difficulty playing quietly
- Is constantly “on the go” or often acts as if “driven by a motor”
- often talks too much

Impulsivity

- often blurts out answers before questions have been completed
- often has difficulty waiting turn
- often interrupts or intrudes on others (e.g., butts into conversations or games)

☐ **the behaviors indicated happens in 2 or more settings (e.g., at both school and home)**

APPENDIX C

Informed Consent

TEXAS WOMAN'S UNIVERSITY
SUBJECT CONSENT TO PARTICIPATION IN RESEARCH
ADHD/CAPD Research Project 940-898-2289

Investigators

Daniel Miller, PhD-Associate Professor (TWU)	Dorothy Grant, PhD-Associate Professor (TWU)
Christine Hudson-Behav. Med. Doctoral Student (UNT)	Jodi Lowther-School Psych Doc. Student (TWU)
Janice Melester-Counseling Psych. Doc. Student (TWU)	Lindy Pottinger-Behav. Med. Doctoral Student (UNT)
Laurel Strahan-School Psychology Doctoral Student (TWU)	

Informed Consent to Participate in Research

1. I hereby authorize the Attention Deficit Hyperactivity Disorder (ADHD)/Central Auditory Processing Disorder (CAPD) Research Project faculty or one of the supervised graduate students to perform the procedures described on the attached informed consent form.
2. These procedures have been explained to me by one of the ADHD/CAPD Research Project Staff.
3. I understand that there will be a one time fee of \$20 to participate in this study payable on the day my child is tested. Checks only will be accepted and must be made to TWU. The fee is to offset the costs of the testing materials.
4. The researchers will try to prevent any problem that could happen because of this research. I should let the researchers know at once if there is a problem and they will help me. I understand, however, that TWU does not provide medical services or financial assistance for injuries that might happen because I am taking part in this research.
5. An offer to answer all of my questions regarding the study has been made and I have been given a copy of this consent form to keep. A description of the possible discomfort and risks reasonably expected have been discussed with me. I understand that I, or my child, may terminate participation in the study at any time.

The following tests will be administered to your child:

- Woodcock Johnson Tests of Cognitive Abilities-a test of cognitive abilities
- Screening Test for Auditory Processing-a screening test for auditory processing problems
- Behavior Assessment System for Children (Self-Report)-a behavioral rating scale
- Receptive One Word Picture Vocabulary Test-a receptive language test
- Attention and Language tests from the NEPSY-a neuropsychological test for children
- Cognitive Assessment System-a cognitive abilities test
- Wechsler Individual Achievement Test-an achievement test for reading, math, and spelling
- Audiological screening by an audiologist

The following tests will be completed by the parent:

- Attention Deficit Disorders Evaluation Scale (Home Form)-a screening test for ADHD
- BASC Structured Developmental History and Parent Rating Scale-a developmental history and abbreviated behavioral rating form
- ADHD/CAPD Behavior Rating –a behavioral rating scale for ADHD and CAPD
- Parenting Stress Index-a brief questionnaire designed to measure your relationship with your child

The following tests will be given to the child's teacher by the parent for completion:

- Attention Deficit Disorders Evaluation Scale (School Form)-a screening test for ADHD
- BASC Teacher Rating Scale-a behavioral rating form

Efforts will be made to prevent any complications that could result from this research. Medical services and compensation for injuries incurred as a result of your participation in the research are not available.

The investigators are prepared to advise you in case of adverse effects, which you should report to them promptly. Investigators may be reached by calling the phone number which appears at the top of this form.

If you have any questions about the research or about your rights as a subject, you should ask the researchers: their phone numbers are at the top of this form. If you have questions later, or you wish to report a problem, you may call the researchers or the office of Research and Grants administration at 940-898-3377.

By signing this consent form the Parent agrees to:

- Participate in an initial intake interview over the phone to verify the child's ADHD/CAPD diagnosis;
- Arrange for classroom teacher to complete a behavioral rating scale on the child;
- Pay a \$20 fee for participation in the study to help offset the cost of the testing materials;
- Attend a five hour session in which they will be asked to fill out forms and be interviewed while their child is being tested;
- Allow their child to participate in this research study.

Child agrees to:

- Attend 5 hour testing session

Signatures

Father

Date

Mother

Date

Guardian

Date

Child

Date

Witness (one required)

Date

APPENDIX D

Summary Of Results

SUMMARY OF RESULTS

	Hypothesis	Confirmed/Not Confirmed
1.	It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Tower subtest of the NEPSY.	Confirmed
2.	It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the number of omission errors on the Auditory Attention and Response Set of the NEPSY.	Not Confirmed
3.	It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Phonological Processing subtest of the NEPSY.	Not Confirmed
4.	It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Planning Scale of the CAS.	Confirmed
5.	It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Attention Scale of the CAS.	Not Confirmed
6.	It is hypothesized that there will be a significant difference between the AD/HD-I and AD/HD-C groups on the Successive Processing Scale of the CAS.	Not Confirmed

The remainder of the subtests from the CAS, NEPSY and SCAN, included in this study, were not predicted to significantly differentiate between the AD/HD-I and AD/HD-C groups.

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